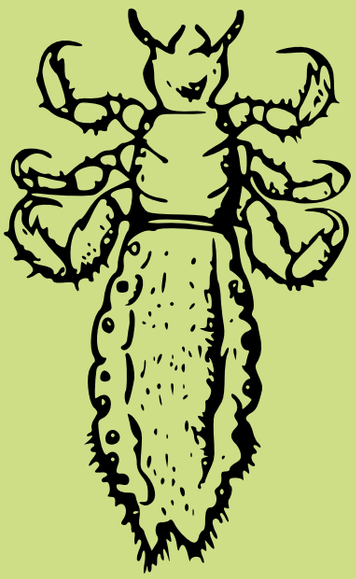
V. Zhdanov

EPIDEMIOLOGY



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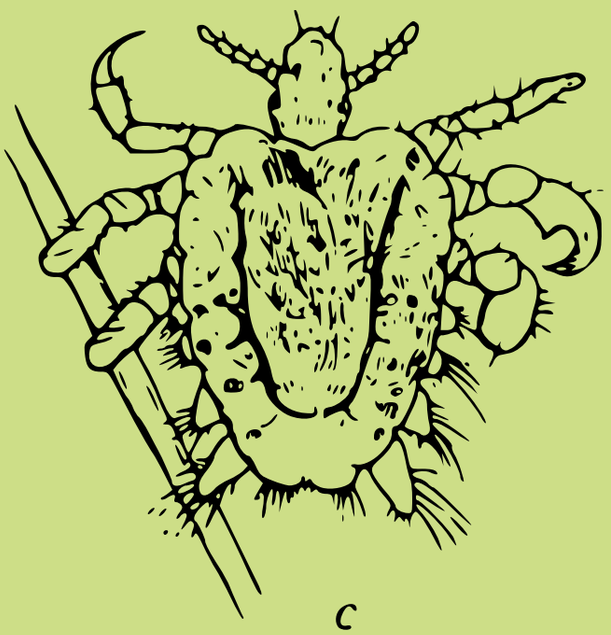

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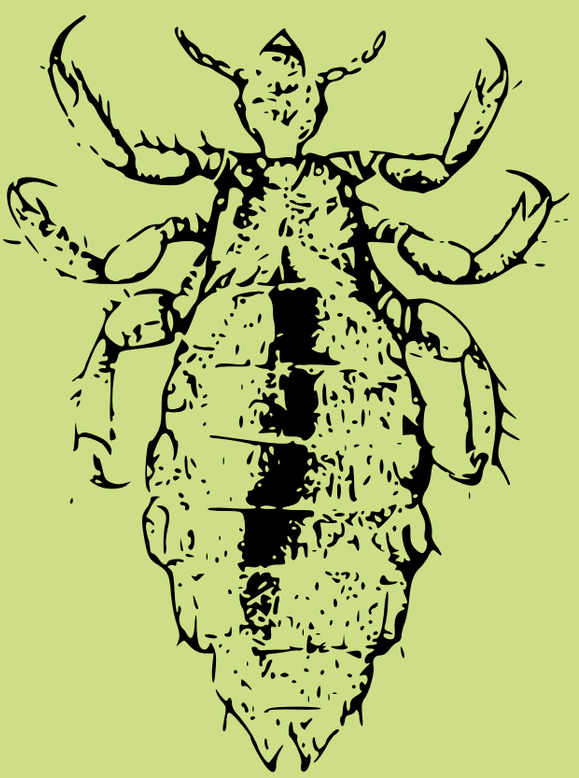

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MOSCOW

V. ZHDANOV

Epidemiology

Accepted as a textbook for
the students of clinical
and pediatric departments
of medical institutes

MOSCOW

Foreign Languages Publishing House

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PART ONE

General Epidemiology

THE SUBJECT AND TASKS OF EPIDEMIOLOGY

The Subject of Epidemiology. Epidemiology deals with infectious, or, in a broader sense, communicable diseases of man. These diseases differ essentially from other pathological conditions affecting human beings in that they are caused by living organisms—bacteria, protozoa, fungi, viruses, helminths and arthropoda which are parasitic on and pathogenic for man. The organisms causing communicable diseases in man are the subject of study by many branches of biological and medical science (microbiology, virology, helminthology and others); however, epidemiology studies certain aspects of the existence of these organisms—for example, why and how certain biological species became the pathogenic agents of human diseases, what peculiar features in man's social life and activities promote the existence of these organisms at the present time. These questions are largely of an ecological nature and therefore *epidemiology might be defined as the ecology of the pathogenic organisms of communicable diseases in human society.*

This definition, however, by no means exhausts the subject-matter of epidemiology. A communicable disease occurs as a result of the interaction between the pathogen and the human organism under specific environmental conditions. This interaction is the essence of the infectious process studied by many branches of medical science (general pathology, immunology, clinical study of infections, etc.). Some questions in the theory of infection have a direct bearing on epidemiology. For example: what is the route the pathogen takes on entering or leaving the organ-

ism; what is the degree and duration of immunity acquired after an infection? We may, therefore, also define *epidemiology as a science dealing with the mechanisms involved in the occurrence of communicable diseases in man.*

This definition, too, fails to cover the subject-matter of epidemiology completely, since specific infectious diseases do not exist in isolation from one another, but are closely interconnected. To illustrate this we may cite three examples—a case of measles in a kindergarten, group food-poisoning, and several cases of brucellosis in a community. Measles occurred after a child had been in contact with an infected person; food-poisoning occurred after a group had eaten insufficiently boiled meat contaminated with salmonellae; cases of human brucellosis appeared after contact with cattle infected with brucellae or after ingestion of brucella-contaminated dairy products. In all these instances, it is possible to establish the causes linking these specific cases of disease. Therefore, *epidemiology may also be defined as a science dealing with the means whereby infectious diseases spread amongst human beings.*

This definition, too, does not cover the entire field of epidemiology. A knowledge of the means by which influenza spreads does not serve to explain the widespread epidemics, or even pandemics, of this disease which occur from time to time, such as the pandemic of 1957, which involved approximately one thousand million people. Likewise, a knowledge of the means by which poliomyelitis spreads is not sufficient to account for the steady and general increase in the incidence of this disease during the first post-war decade. All of these questions must be answered by epidemiology, which may also be defined as a science *studying the causes of the outbreak and subsidence of epidemics.*

Even this does not exhaust the tasks confronting epidemiology. Since it is not only a science but is also concerned with practical activities, it elaborates prophylactic measures for the control and prevention of infectious diseases based on the scientific study of the previously numerated subjects.

Epidemiology is thus the science of the laws governing the appearance and spread of communicable diseases in

human society and of prophylactic measures designed to prevent them.

This definition of epidemiology as a branch of medical science and as an aspect of man's practical activities indicates its connection with other sciences and the system of public health services. These sciences are, first, microbiology (including virology and immunology), parasitology, epizootology, general pathology, the clinical study and therapy of infectious diseases, a number of special clinical subjects (surgery, venerology, dermatology, and others), as well as various aspects of hygiene. Epidemiology comes within the purview of public health services as it is closely connected with applied hygiene (sanitary-epidemiological matters) and occupies a prominent place in the practical activities, not only of epidemiologists and specialists in infectious diseases and hygiene, but also of therapeutists, pediatricians, obstetricians, gynecologists and surgeons, as well as more specialised branches of medicine.

The Methods of Epidemiology. Epidemiology has its own methods of investigation, and at the same time also makes wide use of methods employed by other sciences.

The principal methods of epidemiological investigation are the *epidemiological survey and epidemiological experiment.* The epidemiological survey may be concerned with one case, a group of cases, an outbreak of disease or an epidemic and, finally, it may be concerned with a definite territory and be conducted for a more or less lengthy period of time. The epidemiological survey aims at obtaining data necessary for understanding the causes of the appearance of diseases and for elaborating measures to stop their spread. Usually, in addition to the information obtained by the physician from the patient and his contacts and from a visit to the patient's house and place of work, other investigations must be undertaken: namely, microbiological, serological, clinico-diagnostic (in order to establish a correct diagnosis and ascertain the presence of infection in the patient's contacts), hygienic (to determine the possible role played by water, food and other environmental factors in the transmission of the disease), statistical (in cases of an outbreak on a mass scale), epizootological and parasitological (in cases of infection transmitted by domestic

and wild animals), etc. The scope and nature of an epidemiological survey (as well as of the additional methods of investigation) vary with the diagnosis of the disease, the number of cases and the conditions under which the disease occurs. On the basis of the results of an epidemiological survey, practical measures are instituted to prevent the occurrence of the disease or its further spread.

The epidemiological experiment is employed to test the effectiveness of one or another method of disease control. Following laboratory tests, prophylactic vaccines, sera or antibiotics are put to the final test by epidemiological experiment. This also applies to any other method of combating infectious diseases—isolation, disinfection, segregation, etc.—the effectiveness of which may also be judged by epidemiological experiment. A sufficiently large group of people, living as far as possible under similar conditions, is carefully selected for purposes of epidemiological experiment. This group is usually divided into two numerically similar groups; the trial group is subjected to the action of the factors being tested, while the control group is not. The effectiveness of this factor is then determined by a comparison of the incidence of disease in the trial and in the control groups after a statistical analysis of the results of observations made on both groups.

Surveys and experiments are not the only methods of investigation used in epidemiology. Statistical analysis of the incidence of infectious diseases is of especial importance. The majority are distinguished by seasonal distribution, different reactions of various age groups, some infectious illnesses mainly affecting children, and also the uneven geographical incidence of diseases. A comparison of statistical data collected over a period of several years will show the tendency of a disease to decrease or increase in incidence, or to fluctuate periodically. All these data are indispensable for the correct planning of measures to control and prevent infectious diseases. Working without the aid of statistics in epidemiology is tantamount to working in the dark.

The method of comparative-historical analysis in epidemiology is used to study the evolution of infectious diseases,

the distinctive features of epidemics in various historical epochs, their connection with the socio-economic structure of human society, etc. The method of comparative-historical analysis is also extremely important in evaluating the possibilities of stamping out a given infectious disease.

Epidemiology makes generous use of the methods of investigation employed by allied disciplines—microbiology, general pathology, parasitology, etc., and these methods are frequently instrumental in solving purely epidemiological problems—for example, establishing the required isolation period for an infectious patient, determining the routes of transmission of an infectious disease, discovery of a vector of an infectious disease, etc.

Epidemiological methods of investigation are, in their turn, used in other fields of medical research. Recently, these methods have come to be employed in investigations of non-infectious diseases: cancer, hypertension, cardiovascular diseases, etc. Sometimes we even hear the expression "the epidemiology of non-infectious diseases" applied to the incidence of cancer or atherosclerosis in different age or occupational groups of the population, or when attempting to elucidate the effect of living conditions on the incidence of such diseases. Clearly, the use of epidemiological methods of research in the study of non-infectious diseases, while quite justified, does not imply an expansion of the subject-matter of epidemiology as a science and, therefore, the use of the term for other purposes is purely optional and cannot be considered as strictly scientific.

A Brief History of Epidemiology. Epidemiology is both a very ancient and a comparatively young science. It may be considered old because even in ancient times, when mankind was faced with communicable diseases, people began to work out primitive methods of combating them. It may be considered a young science because its real development started with microbiology, after the great discoveries made by Pasteur and other scientists of that period.

Although in ancient times infectious diseases were ascribed to the work of demons, many anti-epidemic measures were worked out empirically. For instance, variolation

(artificial smallpox inoculation) was used in China about 1,000 B. C., and in India, round about the same time, avoidance of contact with rats was recommended in order to lessen the risk of plague, while in a number of Asian countries, lepers were banished from the community.

The level of culture of both ancient Greece and Rome made possible the understanding that live contact with disease was a cause of epidemics. This concept, met within the works of Hippocrates (5th-6th centuries B. C.), was further elaborated by Lucretius (1st century B. C.). These generalisations were based on observations of numerous epidemics which occurred in the ancient slave states (Hippocrates wrote a special book on epidemics).

This same idea was prompted by the outbreaks of epidemics of grave infectious diseases that occurred during feudalism, especially in the 14th and 15th centuries, when epidemics of plague, smallpox and typhus fever assumed devastating proportions. It was during this period that the concept of the live contact as the cause of communicable diseases was clearly formulated in the works of outstanding physicians—the Veronese Fracastoro (1483-1553) and the Englishman Sydenham (1624-1689). Quarantine and other anti-epidemic measures were introduced at that time, after their effectiveness had been confirmed by practical experience.

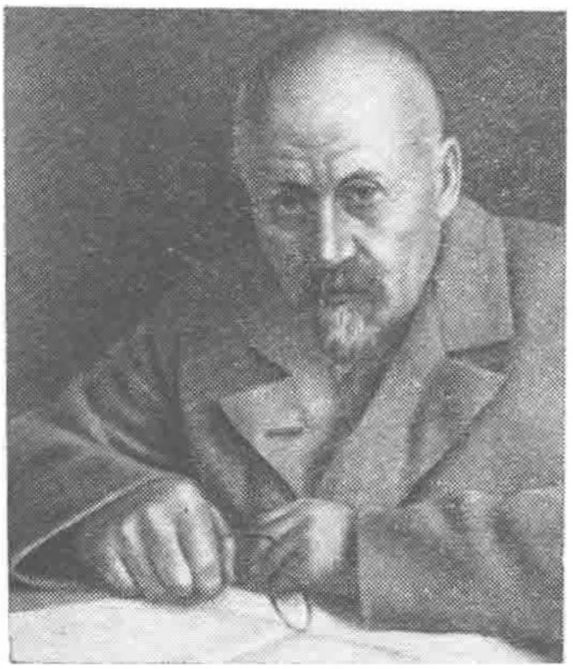
The Industrial Revolution and the development of capitalism lent an impetus to the development of many sciences, including the science of epidemiology, because the inception of this new socio-economic formation was accompanied by outbreaks in city slums of epidemics of intestinal infections, parasitic typhus fevers and tuberculosis, and by the appearance of new diseases in European countries (cholera and yellow fever). At the end of the 18th century Jenner (1749-1823) discovered a method of preventing smallpox by inoculation with vaccinia (cowpox).

It was during this same period that epidemiology arose as a science in Russia where, after the reforms introduced by Peter the Great, economic development began making fast progress. Increased contacts with other countries, as well as wars, were instrumental in introducing plague,

typhus fever, smallpox and other diseases into Russia. One of the first Russian epidemiologists, Danila Samoilovich (1724-1810), convinced that the pathogenic agents of communicable diseases were living organisms, tried to discover them with the aid of the microscope. He helped to combat an epidemic of plague in Moscow (1771-72), organised a quarantine service in the Black Sea coast area, fought in the wars and won world-wide recognition for his works on epidemiology.

Epidemiology was given a new basis and a colossal impetus following the discoveries of Louis Pasteur (1822-1895), Robert Koch (1843-1910), Ilya Mechnikov (1845-1916) and their followers, who proved the microbial etiology of infectious diseases. A knowledge of the pathogens of infectious diseases not only made possible an exact study of their epidemiology but also provided medicine with new weapons in the fight against disease—vaccines and sera.

Amongst the Russian scientists who contributed to the development of epidemiology, mention must be made of G.N. Minkh (1836-1896) and O.O. Mochutkovsky (1845-1903). These scientists infected themselves with relapsing fever and typhus fever and established the presence of the pathogenic organisms of these diseases in the blood stream. They rightly concluded that these diseases were transmitted by blood-sucking insects. The name of Ilya Mechnikov is associated with the modern concept of susceptibility and immunity to infectious diseases. The discovery of viruses is the achievement of D. I. Ivanovsky (1864-1920). S. P. Botkin (1832-1889) was not only an outstanding specialist in internal and infectious diseases, he was also an epidemiologist whose ideas on the nature of infective hepatitis were years ahead of those of his contemporaries. P. F. Borovsky (1863-1932) discovered the pathogenic agent of leishmaniasis (1898), a disease subsequently named after the English scientist Leishman. Mention should also be made of the research done by B. K. Vysokovich (1854-1912) in the field of plague epidemiology, by G. N. Gabrichevsky (1860-1907) on diphtheria (serotherapy) and scarlet fever (streptococcal etiology), by I. G. Savchenko (1862-1932) on cholera (enteral immunisation), etc. N. F. Gamaleya (1859-1949) is



D. K. ZABOLOTNY
(1866-1929)

well-known as the author of numerous researches on various questions of epidemiology and microbiology. I. D. Deminsky (1864-1912) discovered the role of susliks or gophers (*Citellus citellus*) in the epidemiology of plague. Having contracted the pulmonary form of plague in the course of his experimental work, he cabled back to headquarters, requesting that he be considered a case of experimental plague infection contracted by contact with susliks and that his body be autopsied with that in mind. D. K. Zabolotny (1866-1929) established the role of tarbagans in the epizootiology of plague. N. N. Klodnitsky (1876-1938) described cases of plague in camels. L. A. Tarasevich (1868-1927) is known for his research into the epidemiology of typhus fever and tuberculosis. He organised the production of vaccines and sera in the U.S.S.R. Y. M. Martsinovsky (1874-1936) investigated the epidemiology of malaria, tick-borne relapsing fever and leishmaniasis, and was the first to organise an anti-malaria service in the U.S.S.R.

Soviet Epidemiology. In the history of the development of epidemiology, the Soviet period deserves special mention, not only because after the October Revolution our medical science developed rapidly, but also because the theoretical and practical aspects of anti-epidemic work are closely connected with the socio-economic conditions in a country.

There are many references in Marxist-Leninist classics to the social factors which contribute to epidemics of infectious diseases. In capitalist society, exploitation of the workers and the poverty in which they live create conditions favourable to the spread of infectious diseases, particularly in colonial and economically dependent countries. It is clear that cognition of the laws governing the

spread of infectious diseases and the elaboration of effective measures against them also depends on the introduction of social reforms. It is in these contradictions that reasons must be sought to account for some fallacious views expounded in epidemiology, based on idealistic concepts.

Y. N. PAVLOVSKY
(BORN IN 1884)

Soviet epidemiology is based on a materialistic outlook, dialectical materialism. Epidemiology, just as any other medico-biological science, must proceed from the Darwin concept creatively applied. (We have in mind Darwin's theory of evolution and its further development by K. A. Timiryazev, I. V. Michurin and other materialist biologists.)

Outstanding among Soviet epidemiologists were D. K. Zabolotny, who wrote the first manual on epidemiology; Y. N. Pavlovsky, who developed the theory of natural foci of infectious diseases and K. I. Skryabin, who developed the theory of helminthiases. Founders of departments in medical schools and authors of textbooks on epidemiology were G. F. Vogralik (1935), V. A. Bashenin (1938), M. N. Solovyov (1936) and L. V. Gromashevsky (1941). It should not be thought, however, that only these few scientists are responsible for the development of epidemiology. It is the result of the collective efforts of numerous research workers and practical epidemiologists. The pooling of their efforts created Soviet epidemiology and its practical application in the sanitary-epidemiological services.

In other socialist countries epidemiology was developed with the aid of K. Raška (Czechoslovakia), M. Kacprzak (Poland), D. Bratovanov (Bulgaria), and others, as well as by the sanitary-epidemiological services of these countries.

The Significance of Epidemiology. The spread of infectious diseases and the extent to which epidemiologically

K. I. SKRYABIN
(BORN IN 1878)

effective public health measures to combat them are developed, are of considerable economic significance. The Soviet Union provides a good number of examples of the effect of anti-epidemic measures. Since 1917 diseases such as smallpox, cholera, plague, relapsing fever, dracunculosis (dracontiasis), etc., have been stamped out. Today epidemic forms of typhus are practically non-existent. Malaria has been wiped out. Yet only recently these terrible diseases caused great damage to the economy of the country, to say nothing of their high mortality rate and the terrible sufferings that they inflicted upon people. In 1897 there were 300,000 completely blind people in Russia, half of whom had lost their eyesight as a result of smallpox, trachoma or gonorrhea. According to Globa's calculations, an annual expenditure of 30 million rubles was required even for the most miserly maintenance of this army of the blind. In quoting this, L. V. Gromashevsky reminds us that in those years the total annual budget for the Ministry of Public Education was 80 million rubles. In 1946 there were 3.3 million malaria sufferers in the U.S.S.R.; owing to the application of effective measures for the control of the disease, by 1960 it had been eradicated, which, by the most modest calculations, has meant an annual economy of 330 million rubles.

However, even today numerous infectious diseases are still widespread and occasionally cause large epidemics, the most notable being influenza. The influenza pandemic of 1957, apart from exhibiting an extremely high morbidity rate, caused considerable economic damage throughout the world. It was calculated that in the U.S.S.R., for instance, over two thousand million rubles were paid out in sickness benefits.

The significance of measures against epidemics increases

greatly in times of war, when as a result of the disruption of the normal life of the country, there are more frequent epidemics. In the past, wars were invariably accompanied by epidemics of infectious diseases both in the rear and at the front, and the losses suffered by troops due to epidemics were often greater than those sustained in combat. The last two world wars were no exception to this rule although in the Second World War the epidemics were not so devastating because of the progress made by epidemiology and the effectiveness of sanitary measures. This was especially evident in the U.S.S.R., where it was possible to prevent the spread of infection amongst the troops and civilian population by the energetic anti-epidemic measures taken by our health-protection organisations.

L. V. GROMASHEVSKY
(BORN IN 1887)

At the same time the weakness of the anti-epidemic services in Hitler's army was one of the reasons for the serious outbreaks of typhus, dysentery, infective hepatitis, etc., that affected the army and some of the areas in Germany's rear.

THE THEORY OF INFECTION

Definition of Infection. Infection or infectious process is the interaction of a pathogenic parasite, the pathogenic agent of disease, with a human or animal organism under certain environmental conditions.

However, other meanings are frequently ascribed to the word "infection". When we say that "the infection is localised in the liver", we are referring to the pathogen of this infection; the words "infecting agent" are used in the same sense. In the phrase "Infection was transmitted by milk", the transmission of an infectious entity is meant. The word "infection" very often denotes an infectious disease ("Dysentery is an intestinal infection"). Finally, the word "infection" is also used to describe an epidemic process ("There was an increase in the incidence of intestinal infections"). All these uses of the term "infection" are inaccurate and should be avoided. The original meaning of the word should be preserved. Unfortunately this is not an easy task since different interpretations of the word "infection" have become deeply rooted in both medical literature and in everyday speech.

The main and the most important manifestation of infection is an infectious disease, i.e., the development of an infectious process in which pathogenic agents enter an organism, propagate there and interfere with the organism's normal vital activities as a result of morphological and functional damage. Or, on the other hand, an infection may run its course without any apparent clinical manifestations—asymptomatically.

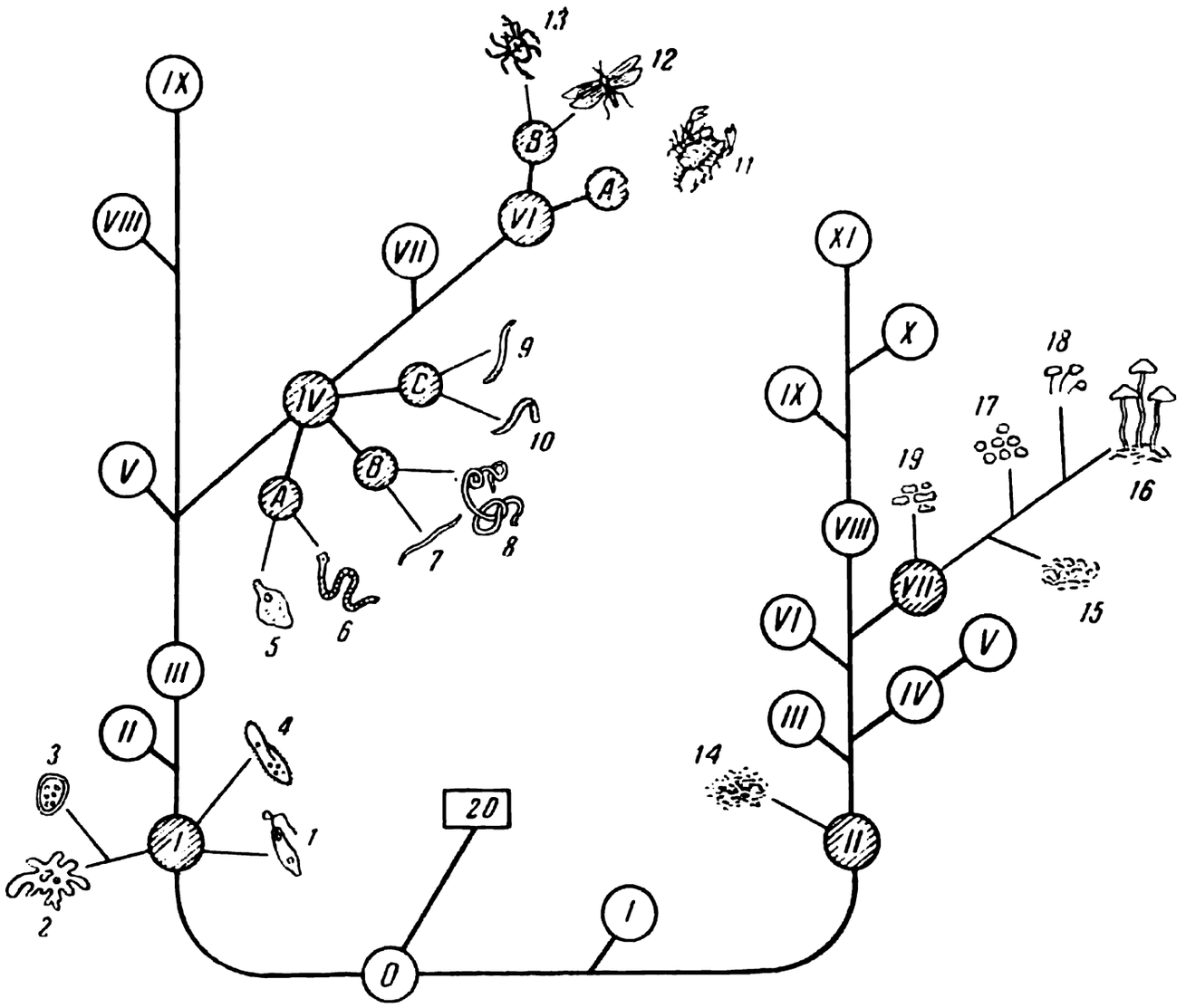


Fig. 1. Parasitism in plant and animal world

Animals. *I*—Protozoa: *1*—Flagellata, *2*—Rhizopoda, *3*—Sporozoa, *4*—Infusoria; *II*—Sponges; *III*—Coelenterata; *IV*—Worms: *A*—Flat worms (Platodes): *5*—Trematoda, *6*—Tapeworms; *B*—round worms: *7*—round worms, *8*—Nematoda; *C*—Annelida: *9*—Echinorhynchus, *10*—Leeches; *V*—Vermoidea; *VI*—Arthropoda; *A*—Branchiata: *11*—Crustacea; *B*—Tracheata: *12*—Insects, *13*—Arachida; *VII*—Molluscs; *VIII*—Echinodermata; *IX*—Chordata.
Plants. *I*—Myxomycetes; *II*—Schizophyta; *14*—Bacteria; *III*—Red algae; *IV*—Green algae; *V*—Diatoma; *VI*—Brown algae; *VII*—Fungi: *15*—Eumycetes, *16*—Phycomycetes; *17*—Ascomycetes, *18*—Basidomycetes, *19*—Imperfect fungi; *VIII*—Moss forms; *IX*—Ferns; *X*—Gymnospermous; *XI*—Angiospermous; *20*—Viruses

Infection and Parasitism. Infectious diseases differ from other diseases afflicting man and animals in that their pathogens are living organisms, parasites. The specific nature of the pathogenic organism as a biological species determines the specific nature of the disease which it causes.

The pathogenic organisms of infectious diseases which afflict human beings belong to various groups of the plant and animal worlds (Fig. 1). A considerable number of dis-

eases are caused by viruses which occupy an intermediate position between plants and animals (influenza, tick-borne encephalitis, infective hepatitis). The pathogens of bacterial diseases (dysentery, plague, diphtheria) belong to the plant world and many diseases (ringworm, favus histoplasmosis) are caused by pathogenic fungi. The pathogens of protozoic infections (malaria, amobiasis, kala-azar), as well as multicellular parasites—helminthes (ascariasis, echinococcosis, schistosomiasis) and the arthropoda (scabies)—all belong to the animal world. Infectious diseases are those caused by microorganisms (viruses, bacteria, fungi, protozoa), while diseases caused by multicellular parasites are called invasive diseases or infestations. Despite the vast differences in biological characteristics and position in taxonomy, all pathogens of infectious diseases have one feature in common, they are all parasites.

Infectious diseases resulted from the evolution of parasitism, and in the long course of the evolution of man and animals, the pathogens of infectious diseases developed from those parasites which were pathogenic and inhabited the host's organism for a more or less lengthy period of time.

In biology, parasites are defined as those biological species which exist at the expense of certain other species and are biologically and ecologically closely connected with them throughout their life span. Parasites subsist on the fluids, tissues and products of the vital activities of their hosts. They may inhabit the host's organism permanently or temporarily (Y. N. Pavlovsky).

Parasitism is an historical phenomenon. There are a great number of intermediate forms between free-living and parasitic species. Therefore, the series of freely moving species, the facultative parasite to the obligate parasite, represents different stages in the development of parasitism. These intermediate forms are met with almost constantly in the study of close "relatives" of the pathogens of infectious diseases.

The development of a biological species which has become parasitic is intimately affected by the evolution of its host. Changes in the conditions of existence of a biological species whose organism is host to a parasite, provide a stimulus

for the parasite's evolution along lines which ensure the preservation of the given parasitic species. Thus, the development of a parasite is, first, influenced by its host's organism (medium of the first order) and, secondly, by conditions under which the host lives (medium of the second order), while the reactions of the host's organism also evolve in response to the development of the parasite within it.

It may then be said that existing infectious diseases are the result of a long-term evolutionary process undergone by parasites and by the organism's reactions in response to the parasites' invasion. This evolutionary process is still proceeding.

The Evolution of Parasites and Their Interrelationships with Higher Organisms. Many species of microorganisms, whose ancestors inhabited water and soil, gradually became adapted to existence in an animal's organism and began their existence as parasites. At first parasitism was accidental and temporary; later it acquired an obligate character as a result of which the organism of the animal-host became the only medium suitable for the existence of the parasite inasmuch as the parasite, by adapting itself to living within an animal's organism to a greater or lesser degree, lost the properties indispensable for its existence in any other environment. The organism of the animal-host took the place of this environment. Groups of related microorganisms are to be found at the present moment that represent different stages in the evolution of parasitism.

For instance, the intestines of man and animals are inhabited by the obligate parasite *Escherichia coli* (*Bact. coli commune*) and by its numerous varieties. Outside the human or animal organism, the coli bacillus can exist a comparatively short time—for several weeks—and then it usually dies. Therefore, the presence of *Bact. coli commune* in water and soil indicates recent fecal pollution. Together with coli bacilli, it is sometimes possible to find in the intestines a related species, *Aerobacter aerogenes* (*Bact. coli aerogenes*), which, if it enters soil or water, may remain active for several months given favourable conditions, e.g., the presence of organic substances. Therefore, the presence of *Bact. coli aerogenes* in water or soil in the absence of *Bact. coli commune* is indicative of old fecal contamination. Gram-negative bacteria related to the above-mentioned species may be found in soil and water which they normally inhabit; and on entering the intestines, they perish almost immediately. Thus, gram-negative soil and water bacteria, *Bact. coli aerogenes*, and *Bact. coli commune*

are, in a way, stages in the evolution of a group of related species—from saprophytic, free-living forms (soil and water bacteria), through facultative parasitism (*Bact. coli aerogenes*) to obligate parasitism (*Bact. coli commune*).

Another example is the relationship between lactic acid bacteria and streptococci whose genetic kinship has recently been established. Lactic acid bacteria are widely spread in nature, as are the leukonostocs or the so-called acidilactici streptococci which are closely related to them. Evidently, these saprophytic forms developed into various species and varieties of streptococci which are constant inhabitants of the skin, the mucous membranes of the respiratory tract and of the intestinal tract of man and animals (especially streptococci and enterococci). As distinct from saprophytic leukonostocs, streptococci are strict parasites and perish very quickly outside the animal or human organism.

The transition from the saprophytic to the parasitic mode of existence is accompanied by the loss of adaptive mechanisms and functions, necessary and useful during the organism's separate existence, and the acquisition of mechanisms and functions necessary and useful for parasitic existence.

Thus, the coli bacillus, after becoming a parasite inhabiting the intestines of man and animals, lost its numerous enzymes which enabled it to digest simple organic compounds. These enzymes can be found in related semisaprophytic forms (this principle is the basis for the differentiation between *Bact. coli aerogenes* and *Bact. coli commune* by means of the acetylmethyl-carbinol formation reaction). In streptococci, as compared with leukonostocci, the enzyme systems required for saprophytic existence are still further reduced. At the same time, the streptococci have developed new functions, for example, a capacity to cause hemolysis of erythrocytes, not possessed by leukonostocs, etc.

Adaptation to a parasitic existence is accompanied by profound changes in the biological properties of microorganisms, as a result of which the organism of the host becomes the only possible medium for their existence, except for the artificial media created under laboratory conditions.

In their initial stages of evolution microorganisms inhabit the skin, the cavities of the organism that communicate with the environment, the gastro-intestinal tract and the respiratory tract, and their mucous membranous linings. The microorganisms feed on the contents of the intestines, mucoral secretions and dying cells. Many parasitic organ-

isms still exist in the integuments and cavities of the organism, while other parasites penetrate more deeply into the organism—into the epidermal tissues and the blood, into the internal organs, etc., finding more favourable conditions of existence there. As a result, numerous fungi developed the ability to live as parasites on the epidermal tissues of the skin and the hair; *Entamoeba histolytica* inhabits the mucous membranes of the intestine, and hemolytic streptococci are to be found in the lymph nodes of the nasopharynx, etc. Examples of deep penetration of parasites into the organism are the parasitism of the plasmodium of malaria in erythrocytes, of rickettsia in the endothelium of blood capillaries, of tuberculosis bacilli in the tissues of internal organs, etc.

Some parasites, as they became adapted to their parasitic existence in the tissues of the host, turned into very specialised species, which were able to exist and propagate in certain tissues only. So much so that, for instance, the pathogens of ringworm can propagate solely in the epidermis and the hair; in deeper layers of tissue they die. The parasite of malaria develops only in erythrocytes (excluding the extra-erythrocytic stage of its development); the dysentery bacillus grows only in the walls of the intestine, etc. This specialisation in parasites is sometimes termed tissue tropism. Tissue tropism is especially marked in viruses which are strict intracellular parasites. The virus of trachoma can develop only in the conjunctival epithelium of the eye, influenza viruses are found solely in the epithelium of the respiratory tract and the virus of tick-borne encephalitis, in cerebral tissue.

In the course of its evolution, the pathogenic parasite frequently adapted itself to parasitism in organisms of quite definite biological species of hosts: e.g., typhoid bacteria are parasitic solely in the human organism; the virus of foot-and-mouth disease develops predominantly in the organism of the ungulates; different species of malaria plasmodia have quite definite hosts—human beings, mammals, birds.

However, besides those forms which became narrowly specialised, there are numerous parasites that have adapted themselves to parasitism in the organism of many biological

species, not infrequently very remote from each other in the biological hierarchy. Thus, the virus of rabies may be parasitic in the organism of any mammal; the virus of psittacosis occurs in the organism of birds and human beings; numerous parasites of human beings, mammals and birds are at the same time parasitic on arthropoda. In this last case, however, we are dealing with a peculiar type of specialisation involving a change of host.

The interrelationship of microorganisms and hosts which developed in the course of evolution may be quite varied. In some cases, microorganisms occur on the surface of the skin and mucous membranes, or in the lumen of the intestines and are neither harmful nor useful to their hosts; they feed on excreta or on the contents of the intestines and, in essence, lead a saprophytic type of existence. Examples of such relationships are the many species of non-pathogenic protozoa (amoebae, infusoria) which inhabit the intestines of man and animals, and the micrococci and sarcina found in the mucosa of the mouth and nasopharynx. Relationships of this type are termed commensalism.

In other cases, both partners benefit from this mode of existence (mutualism or symbiosis in the narrow sense of the word). Thus, the bacteria and infusoria which inhabit the intestines of ruminants are undoubtedly useful to the latter since they assist these animals to digest cellulose. The infusoria in the intestines of termites are not only useful but necessary to these insects, since without them the termites cannot live. In many species of insects, bacteria and fungi are present in deep-lying tissues, serving as distinctive organs whose significance is not always clear.

In still other instances, parasitism is harmful to the host since parasitic microorganisms acquire pathogenic properties; their propagation and vital activity in the host's organism lead to the development of infection. It should be pointed out that pathogenicity is, in a way, a relative characteristic. Thus, on the one hand, *Escherichia coli* may cause certain pathological processes under definite conditions and, on the other hand, the pathogen of typhoid fever may be parasitic in the organism for a long time without causing any substantial harm (the carrier-state). Hence,

infection is one of the trends in the development of parasitism.

The total number of known pathogens of human diseases, including variants, exceeds 3,000 and their list increases from year to year. Since most of them are obligate parasites, they continue to exist as biological species owing to their transmission from infected to healthy organisms.

In the course of the evolution of pathogenic parasites various means of transmission from infected to healthy organisms arose and, accordingly, different mechanisms for this transmission were developed (see below). Thus, the infectious and epidemic processes are interrelated.

Specificity of Infection. The specificity of infectious processes, which is manifested by distinguishing clinical features characteristic of each infectious disease, depends, first and foremost, on the specific properties of the pathogen involved.

Each pathogen of an infectious disease is equipped with a specific set of instruments enabling it to attack and overcome the resistance of the macroorganism. These instruments include bacterial exo- and endotoxins and other toxic substances, found in rickettsias and viruses, hemolysins, capsules, enzymes, motile apparatus, etc. That is why the harmful effects of microorganisms and other pathogens of infectious diseases are so specific and varied.

The reactions of human and animal organisms to the penetration of pathogens are no less specific. The combined effect of various natural barriers (the skin, mucous membranes and their secretions, lymph nodes, bactericides, inhibitors in the blood and tissues, etc.) and specific antibodies leads to complicated protective reactions of the organism, inflammatory and fever reactions, allergy and immunity which are specific in different infectious diseases.

It should be added that variability in the pathogens of infectious diseases and in individual features of protective reactions in different human beings and animals depends, in turn, on environmental changes. Consequently, not only do the clinical manifestations vary in different diseases, but so does the clinical course in different patients.

Manifestations of Infections. The infectious process does not necessarily manifest itself in the form of a disease

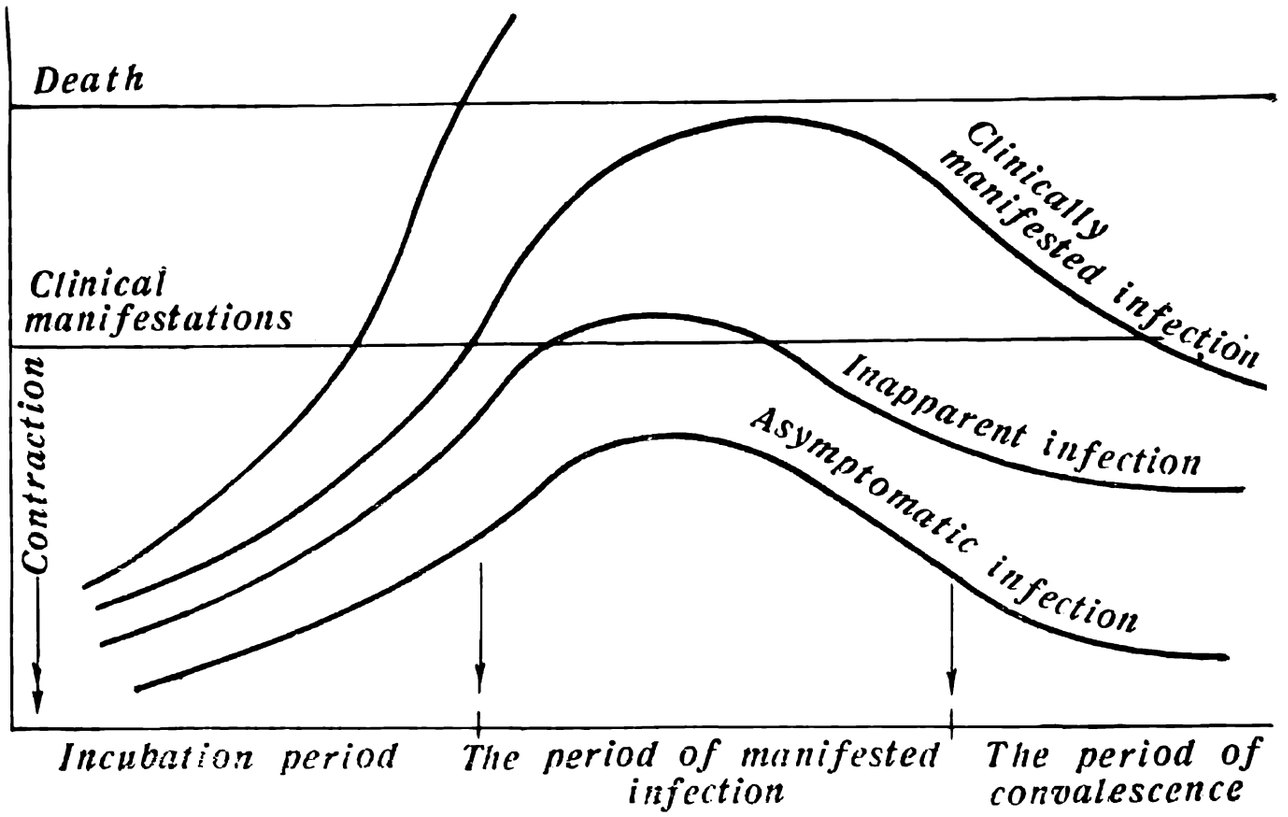


Fig. 2. Forms of manifestation of infection

(Fig. 2). Under the influence of numerous factors (the peculiarities of the pathogen, the infective dose, reactivity of the organism, preventive treatment, etc.), the infectious process may be interrupted or fail to reach a stage recognisable as a disease. Therefore, according to the degree of clinical manifestations, obvious, mild or asymptomatic (inapparent) forms of a disease are distinguished. The disease may take an acute, abortive or chronic course. Asymptomatic forms play an important role in some diseases, both during the epidemic process (healthy carrier-state) and in the development of collective immunity by the population. In many diseases (diphtheria, influenza, scarlet fever, etc.), asymptomatic forms occur during reinfection, i.e., repeated infection after having suffered from a disease. In some diseases, asymptomatic forms do not occur and the disease always takes a clinically manifested course (smallpox, plague, etc.).

Reinfection should not be confused with superinfection, which is a repeated infection occurring while the infectious process has not yet ended. Superinfection does not usually

alter the course of an acute infectious disease, although it may have some effect on the course of a chronic illness. Thus, in tuberculosis, superinfection frequently leads to a new outbreak of the abating infectious process.

Asymptomatic infection should be differentiated from latent infection which is largely observed in chronic infectious diseases. Usually latent infection is a phase of the infectious process.

In certain cases, latent infection may be transmitted by the mother to the fetus. Such fetal infections are observed in syphilis, leprosy, toxoplasmosis and, apparently, in infective hepatitis. According to the virus theory on the etiology of neoplasms, intrauterine transmission of carcinogenic viruses is also possible.

In medical literature, the term "mute infection" is occasionally met with, the meaning of which is not quite clear; in some cases it may mean asymptomatic, and in other cases, latent infection.

According to the localisation of the pathogen in the organism, we differentiate between a focus of infection and a generalised infectious process. In most cases, localisation and generalisation of infection are two stages of an infectious process. Thus, for example, at the beginning of the infectious process the pathogen of typhoid fever, for instance, inhabits the intestinal wall (primary localisation) and only later is carried by the blood stream throughout the whole organism (generalisation), after which it settles again in the intestinal follicles, spleen and bone marrow (secondary localisation). This change in the phases of localisation and generalisation, as well as the formation of infectious foci are to be observed in tuberculosis and syphilis. The spread of the pathogen from the foci of infection is often called the dissemination of infection.

The origins of infections are exogenous and endogenous, the latter also being called autoinfections. The majority of acute infectious diseases which are transmitted epidemically are exogenous. Zoonoses are also exogenous. A number of chronic and latent infections are endogenous. Streptococcal infection is a typical example of the latter type and may occur in the form of tonsillitis, rheumatic carditis or other processes connected with the formation of a focus

of infection in the tonsils and with periodic aggravations of a latent infection.

Endogenous infections are frequently caused by conditionally pathogenic microorganisms inhabiting the human organism—bacteria (streptococci, pneumococci, staphylococci, fusobacteria, *Escherichia coli*), fungi (yeast mycoses developing as complications in the course of antibiotic therapy), viruses (adenoviruses and latent intestinal viruses)—all of which, under the influence of various factors, weaken the organism's capacity for resistance.

Besides infections caused by only one pathogen, there are infections which are called mixed. In actual fact, the majority of infectious processes occur as mixed infections. For example, influenza is almost invariably accompanied by the development of some secondary infection caused by staphylococci, streptococci, pneumococci, and other conditionally pathogenic inhabitants of the nasopharynx. This secondary infection is the chief cause of complications in influenza. The mixed infection in measles and diphtheria acts in much the same way. Smallpox is sometimes accompanied by staphyloccal and streptococcal infections; these same pathogens always accompany cutaneous leishmaniasis. Intestinal infections, dysentery in particular, are invariably accompanied by dysbacteriosis of the intestines which plays an important part in the development of chronic dysentery. Protozoan infections and helminthiases often accompany the course of dysentery. Gas-gangrene nearly always develops as a mixed infection. Some infections are possible only when several pathogens develop simultaneously (fusospirochetosis).

The pathogenesis of infectious diseases is extremely varied although there are certain common features that are characteristic of all infectious diseases. After the transmission of infection and the penetration of the pathogen into the organism the incubation period commences, followed by the appearance of clinical manifestations of the disease which are usually preceded by prodromal phenomena. A disease takes its course in conformity with its specific characteristics (acute, chronic or relapsing, etc.). As a result of the disease and also its course, a greater or lesser degree of immunity develops.

The pathogenesis of an infection determines its clinical manifestations. A combination of local and general clinical manifestations is characteristic for the majority of infectious diseases. Among syndromes common to all diseases the most characteristic are fever, pain, dizziness, weakness, adynamia and other manifestations of intoxication of the nervous system, including even infectious psychoses. These manifestations vary with each disease. The character of the pain syndromes and the fever is very important in establishing a correct diagnosis of an infectious disease.

Local manifestations that depend on lesions in various tissues, organs and systems are even more varied.

Lesions of the skin and mucosa in the form of various rashes are observed in many infectious diseases. The etiology of rashes and enanthemas may be manifold. In some cases, typical infectious granulomas develop in those sites where the pathogen accumulates and multiplies (typhoid fever, smallpox). Rashes, however, may also have an allergic character (brucellosis, eruptions in various dermatomycoses, etc.).

Many infectious diseases exhibit symptoms of a gastrointestinal nature, which are often extremely pathognomonic.

In many infectious diseases the respiratory organs become involved in the pathological process and in some, the symptoms exhibited by these organs are the chief clinical signs.

Functional disturbances in the cardiovascular system are frequently observed in many infectious diseases, and are usually caused by fever and the general state of intoxication of the organism, although they are sometimes of a specific nature.

The hemapoietic and lymphatic systems are almost always involved in the pathological process in infectious diseases, and this is reflected in the changes which occur in the blood picture, predominantly in the white blood cells (leukocytosis, leucopenia, qualitative changes in the blood cells, etc.), and which depend not only on the type, but also on the stage of the disease.

The bone-joints and muscular apparatus may also be involved in the pathological process.

Disorders of the nervous system are observed in almost all acute and in many chronic infectious diseases.

Hence, the clinical picture of an infectious disease is a combination of general and local clinical manifestations specific for every nosological entity.

However, although each disease takes a specific clinical course, it varies considerably in each individual case. These variations depend on the individual peculiarities of the human organism which are very difficult to foresee or take into account, as well as a number of other factors such as age, sex, nutrition, living conditions, etc. For example, numerous diseases take a different course in children than in adults. This may be accounted for by the physiological peculiarities of children and also by the fact that children, as a rule, suffer from primary infections while adults suffer from reinfections (influenza, tuberculosis, diphtheria, etc.). The quantity and quality of food, especially the vitamin content of the diet, exert an important influence on the course of an infectious disease. Therefore, the clinician should not treat the infectious disease but rather the infectious patient.

THE THEORY OF THE EPIDEMIC PROCESS

The Epidemic Process. Since pathogens of the infectious diseases are living organisms which lead a parasitic existence, their reproduction must be a continuous process. This means that any infectious disease must be an uninterrupted chain of infectious processes linked to one another. This chain of infection and the resulting infectious processes, alternating with the emergence of the pathogen into the environment and resembling a kind of relay race, is called an *epidemic process* if human beings are involved, or an *epizootic process* if animals are concerned.

Naturally, the epidemic process must not be understood in too simplified a fashion—as a direct sequence of interrelated diseases. One infectious disease may lead to a simultaneous outbreak of a number of infections and, vice versa, a group of diseases may prove to be a kind of blind alley since no further cases of infection will follow.

For example, observation of the morbidity rate of measles, an infectious process in which clinical symptoms are always clearly manifested, shows that its incidence in a populated area is invariably the sum total of isolated cases, family foci and outbreaks of the disease amongst groups of children, in nurseries and schools, etc. (Fig. 3).

The infectious process does not necessarily manifest itself as an infectious disease and, therefore, its asymptomatic forms may serve as the connecting links in one continuous process, these forms frequently predominating over clear cases of clinical disease.

Poliomyelitis is a good example of this form of the epidemic process, since in this disease an overwhelming num-

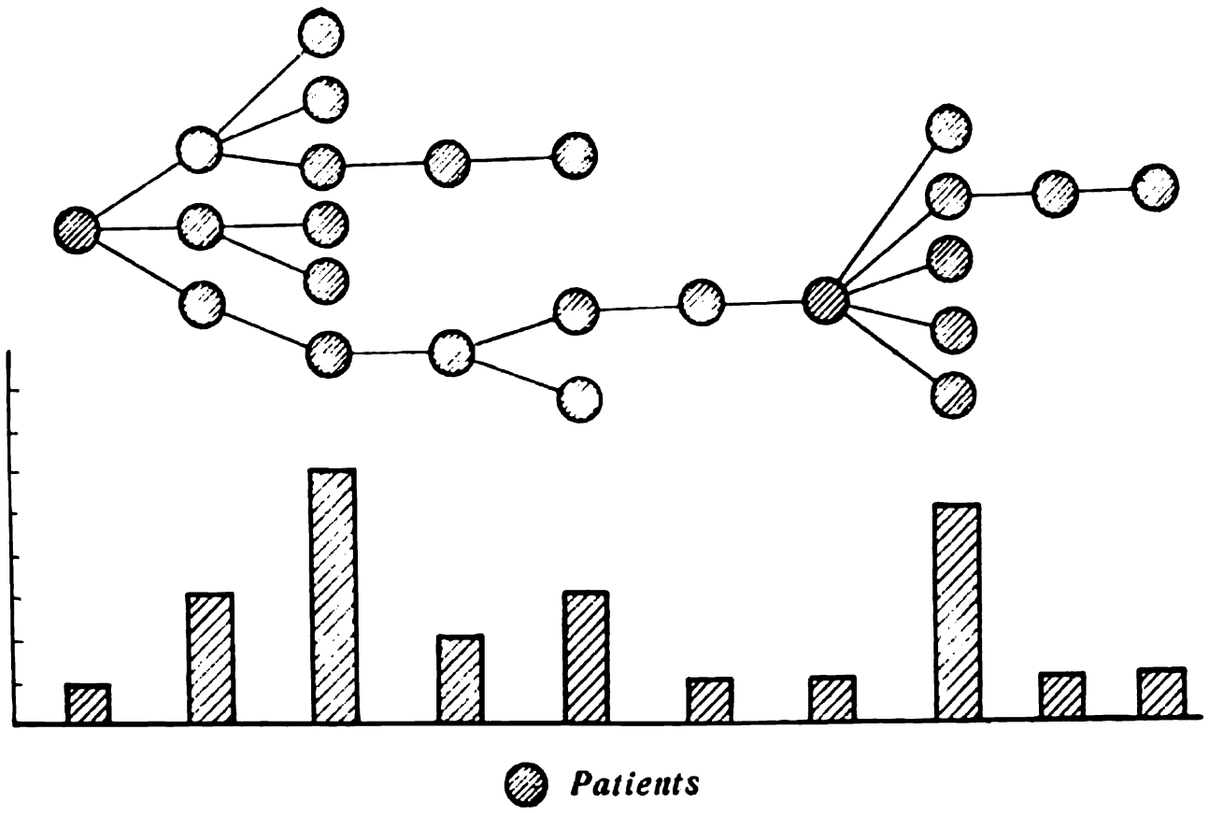


Fig. 3. Epidemic process in measles

ber of cases are asymptomatic infections or non-paralytic forms of the disease which are usually difficult or impossible to diagnose, while the paralytic forms are relatively rare manifestations of the infectious process. Nevertheless, the asymptomatic and non-paralytic forms of poliomyelitis are extremely important links in the epidemic process of this disease, which give the impression that it occurs as unrelated isolated cases (Fig. 4).

Finally, the pathogen may remain in the environment for a long time, which can result in long intervals between two consecutive diseases. In cases of anthrax, for instance, whose pathogen can be preserved in the soil for decades in the form of viable spores, the epizootic process may have apparently long interruptions in which there are no outbreaks of the disease among animals.

Nonetheless, the continuity of the epidemic process is always preserved, regardless of the variety of forms it may assume and, on the other hand, any interruption in this process means the eradication of a given infectious disease, as is well illustrated by the eradication of smallpox, cholera and relapsing fever in the Soviet Union.

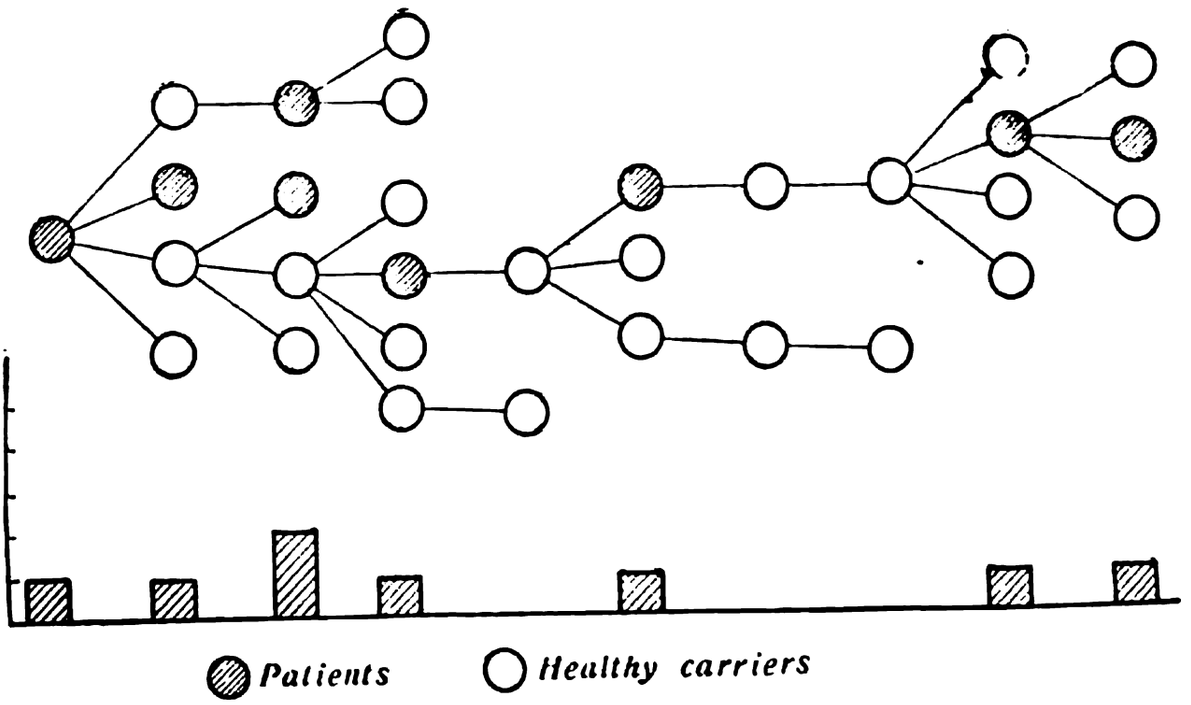


Fig. 4. Epidemic process in poliomyelitis

Smallpox was eradicated throughout the territory of the U.S.S.R. in 1936. And not a single indigenous case of this disease has been registered in the country since that time. The few cases and minor outbreaks reported occurred in frontier areas and were invariably brought in from neighbouring countries (Iran, Afghanistan). One such outbreak occurred in an unusual area—Western Ukraine—in 1946; an epidemiological survey established that the disease had been introduced into the area by demobilised servicemen from North China where there had been an epidemic of smallpox.

Smallpox was brought to Moscow from India in December 1959 by an artist K. who, while visiting India, had become infected there and returned to Moscow during the prodromal period of the disease. As a result he infected members of his family and some of the medical staff at the hospital tó which he was taken. However, the spread of the disease was checked by timely and effective anti-epidemic measures including mass immunisation.

Shortly before the Second World War relapsing fever was eradicated in the U.S.S.R. And throughout the war, despite the difficult sanitary conditions and pediculosis affecting a part of the population, no cases of relapsing fever were registered. The disease made its appearance at the very end of the war in Turkmenia, having been brought in from Iran, and was spread by masses of returning evacuees to the Ukraine and some other parts of the country. By the end of the forties, relapsing fever was eradicated for the second time; since then, not a single case has occurred.

The example of anthrax shows clearly that intervals occasionally observed in the epidemic process and sponta-

neous outbreaks of this disease are illusory and can be explained by our ignorance of the details of the epidemic process concerned. In this respect, the example of typhus fever is very instructive. Typhus fever as an epidemic disease was practically wiped out in the Soviet Union by the beginning of the fifties. Nevertheless, sporadic cases are still registered, though the possibility of infection by lice can be excluded. The cause of these "spontaneous" cases became clear after it was established that some persons who had had the disease in the past harboured rickettsias for a long time. This resulted in relapses, sometimes decades later. In the light of these data, it must be concluded that the infectious process in typhus fever does not necessarily end with the recovery of the patient but may go on for years in the form of a latent infection which may manifest itself at some time as a relapse or recurring infection.

Links in the Epidemic Process. The continuity of the epidemic or epizootic process is maintained by the pathogen moving from the host's organism to the environment. Thus, the shortest period in the epidemic process consists of three links: the infected human or animal organism which is the *source of infection*, various elements of the environment that ensure transmission of the pathogen, or the *factors of transmission* of the infectious entity and, finally, the *susceptible human or animal organism* which receives the pathogen and in its turn becomes the source of infection in the next step in the pathogen's cycle (Fig. 5).

Sources of Infection. The source of infection is the medium in which the pathogen of an infectious disease lives and reproduces itself. Due to the parasitic nature of pathogens, it is the infected human or animal organism (usually diseased but occasionally healthy) that is the source of infection, reservoir of the pathogen (L. V. Gromashevsky).

There are certain data which apparently contradict the above statement. For example, the typhoid bacterium is able not only to exist but also to reproduce itself in milk; leptospirae propagate in water containing a slight amount of protein; the bacillus of botulism—*Clostridium botulinum*—only causes disease when it has multiplied in food and had produced a considerable amount of toxin; the presence of *Clostridium botulinum* in the human intes-

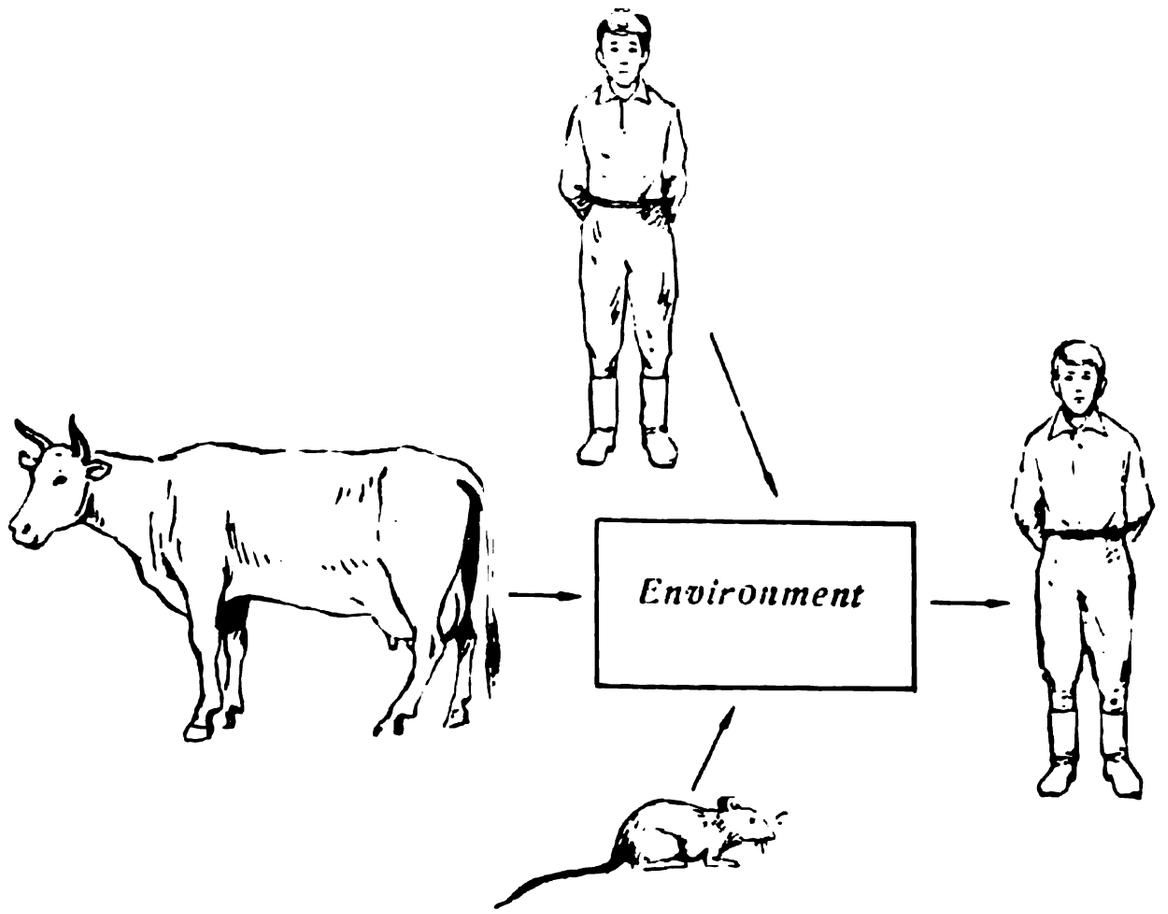


Fig. 5. Links of the epidemic process

tines is not accompanied by any harmful phenomena. In all of the examples given above, various non-living environmental factors seem to serve as sources of infection.

This, however, is not the case. In the case of the typhoid bacterium, it is the human organism and not the milk which provides the natural environment for the existence of the bacillus. Neither milk nor any other food will ensure the preservation of this parasitic organism. Its preservation is due to its adaptation to life within the human organism. In this particular case, milk may be regarded as an imitation of the natural environment of the bacterium (the intestine and its contents) and that is why the typhoid bacterium can reproduce itself in milk. The same holds true of water for leptospirae, which, however, is soon cleared of these bacteria unless they are reintroduced into it with the urine of rodents and domestic animals who, as hosts, harbour leptospirae. The example of the bacillus of botulism proves that the human organism is sufficiently well-adapted to neutralise the pathogenic effects of these bacilli, unless

large amounts of them and of the products of their vital activities enter the intestines. Then the compensatory mechanisms of the human organism are unable to cope with overwhelming infection and clinical disease ensues.

Some exceptions to the definition of the source of infection given above may be found in cases where the pathogen has not yet developed into a complete parasite on man or animal. This applies, in particular, to certain types of mildews and yeast fungi which may cause diseases in man and animals (aspergillosis, yeast mycosis), but which at the same time lead a saprophytic existence in the environment. This particular case is an example of the initial stage in the formation of parasitic organisms—pathogens of infectious diseases.

In addition to the term "source of infection", similar phenomena are termed the "reservoir of the pathogen" (infectious entity, pathogen). Although these two terms are often used synonymously, it is more correct to think of the reservoir of the pathogen as the aggregate of biological species of animals (in many cases, it is only the human being) serving as natural hosts to a given parasite. When the term "source of infection" is used, what is meant is the specific organism or group of organisms causing a particular infection.

All infectious diseases afflicting man can be divided into two large groups according to the nature of the reservoir of pathogen; those in which man is the sole reservoir—anthroponoses, and those which are transmitted by animals—zoonoses.

The most common human diseases belong to the group of anthroponoses—influenza, measles, dysentery, infective hepatitis, malaria and many others. Their pathogenic agents are obligate parasites, very often so adjusted to existence in the human organism that they develop in the organism of another species with great difficulty or not at all. The causative agents of malaria, infective hepatitis and typhoid fever are examples of this strict adaptation. Even in monkeys, a species very closely related to man, these organisms fail to produce the same type of infection as that observed in man. Clearly, man is the sole reservoir of pathogens in this group of infectious diseases.

The infectious process may be clearly manifested or asymptomatic. Consequently, both a carrier and a diseased person may be a source of infection. It should be pointed out that the roles of the patient and the carrier differ with different diseases.

It is important to know the duration of the infectious period in order to establish whether the patient is a source of infection. The course of a disease may be divided into three periods: incubation, period of clinical manifestations and convalescence. The infectious period varies in different diseases within a very broad range. In some diseases, e.g., influenza, infective hepatitis, etc., the patient becomes contagious at the end of the incubation period while in the majority of infectious diseases the patient is not contagious at this time. The highest degree of infectiousness usually coincides with the period of clinical manifestations of the disease.

In some diseases the communicable period ends before the clinical course has ended, although in the majority of cases the organism only rids itself of the pathogen by the end of the convalescent period.

In a number of diseases the infectious process always has a clearly manifested clinical course and form. Smallpox and measles are typical examples. The disease sets in at the end of the incubation period, always has a clearly manifested clinical course and is accompanied by the development of immunity which in the final stages frees the organism from the pathogen. The immunity is so stable and marked that for the rest of the patient's lifetime recurrence of the same disease (with extremely rare exceptions) and even asymptomatic infection is impossible. Clearly, in smallpox and measles the only possible sources of infection are the patients.

In other diseases healthy carriers may also be sources of infection. Typhoid fever is a typical example. Here the clinical process is usually clearly shown. However, not all convalescents are rid of the pathogens immediately; these continue to be excreted from the intestinal lumen for several weeks after the end of the convalescent period. The convalescent is rid of the typhoid bacillus only one and a

half to three months later. This is an example of the carrier-state in the period of convalescence.

In some patients, approximately three or five per cent of those who have had typhoid fever, the pathogenic agent of this disease remains in the organism for a long time after convalescence, sometimes even for life. In this case, it lodges in the biliary ducts or kidneys and is excreted into the environment with the urine or feces. This type of carrier-state is called chronic. Finally, there is a certain group of patients who, when infected by the pathogen of typhoid fever, do not actually develop the disease, but become asymptomatic carriers of the infection and excrete typhoid bacteria into the environment from the intestine. This type of carrier-state is called the healthy type.

Thus, in typhoid fever not only a patient but also carriers can be sources of infection. In turn, the carriers are divided into healthy and convalescent carriers who can be acute or chronic carriers according to the duration of the condition. Of course, the significance of the different categories of the sources of infection in typhoid fever varies. Patients suffering from clinical forms of the disease at its peak, when typhoid bacteria are to be found in the intestines in vast quantities and are excreted in large numbers into the environment via the urine and feces, are unquestionably more contagious than chronic carriers who periodically excrete small amounts of bacteria into the environment. At the same time, the known patients are isolated and in this sense are less dangerous to the community than the undetected carrier who can infect a great many people in the course of his lifetime.

Therefore, the epidemiological significance of various categories of patients (those suffering from clinically manifested or atypical forms of the disease) and the various categories of carriers (convalescents or healthy, acute or chronic carriers) not only depends on the features of the pathogenesis of the disease but is also determined by the specific conditions surrounding the source of infection.

In zoonoses the natural reservoirs of the pathogen are various species of animals which can be sources of infection for man. Zoonoses include a great number of known infectious diseases affecting humans, but by the incidence

of disease caused they occupy second place. It is characteristic of a large majority of zoonoses that they affect a fairly wide range of animals (a wide spectrum of the agent's pathogenicity). This is understandable since parasites whose pathogenicity is confined to only one or several related species cannot possibly become a pathogenic agent for man.

In the majority of zoonotic diseases, wild animals are the reservoirs and man is a mere accidental link in the epizootic cycle of the parasite. Thus, for example, the anicteric type of leptospirosis is a disease of small rodents transmitted via water. If man enters the environment in which leptospirosis is endemic, he may become infected with the disease. Tick-borne encephalitis is a natural infection of chipmunks and other rodents inhabiting the taiga and other forest areas, and is transmitted by the bite of a tick. If people entering the area in which the disease is widespread are bitten by infected ticks, they are liable to contract the disease. Tularemia affects numerous species of rodents, particularly water-voles, sometimes incorrectly called water-rats, which are very important reservoirs of the pathogen. Human beings contract the disease while hunting and skinning infected animals.

All these examples show that zoonoses affecting wild animals exist apart from man; they form natural nidi of infection and people contract the disease when in the course of their activities they come in contact with animals which are the natural hosts of the parasite. In the case of the leptospirosis, this activity is farm work in marshy areas; in tick-borne encephalitis, timber-felling and geological survey work in the taiga; in tularemia, fur trapping and hunting, etc. The theory of the natural nidi of infectious diseases has been elaborated by the outstanding Soviet scientist Academician Y. N. Pavlovsky. Later we shall dwell on this theory in greater detail.

Reservoirs of pathogenic agents of another group of zoonoses are found among domesticated animals and rodents inhabiting human dwellings. Brucellosis is an example of a zoonosis of domestic animals which affects cattle, sheep and goats, as well as pigs. Human beings become infected with brucellosis in the course of tending domestic animals or using their milk and dairy products. Leptospiral jaundice

is an example of a zoonosis in which rats are the natural reservoirs of its causative agent. The contamination of drinking-water and food with rats' urine leads to man's infection.

A number of zoonoses affect both wild and domestic animals. Above we gave an example of the anicteric type of leptospirosis whose reservoir are mouse-like rodents inhabiting marshy areas. However, cattle may also be involved in the epizootic process since they are quite susceptible to leptospiroses and people are more likely to become infected by them since they deal more with cattle than with rodents. Rabies is another illustration of this type of relationship between people and animals. Wolves are the natural reservoirs of the causative agent of rabies and the disease is to be found in areas uninhabited by man. Since dogs are common in present-day society, they become an additional reservoir of rabies and are a greater source of infection for man than wolves.

The examples of leptospirosis and rabies illustrate another principle often observed in zoonoses, namely, the existence of primary and secondary reservoirs of the causative agent of a disease. Obviously, in the case of rabies, wolves, and in the case of anicteric leptospirosis, rodents are the primary reservoirs of these pathogens since these diseases existed as infections of the above species of animals long before the origin of man. Secondary reservoirs in the case of these two diseases—dogs in rabies and cattle in leptospirosis—appeared as a consequence of man's social and economic activities. At the same time, these secondary hosts of the causative agents are more frequently the sources of infection for man than the primary hosts which are also the primary reservoirs of the causative agents (Fig. 6).

Forms of the sources of infection described for anthroponoses (patients and carriers) are also observed in zoonoses.

In certain infectious diseases (some types of helminthiases), the parasite undergoes a complex development cycle in the organisms of several hosts, amongst which man is either an inevitable link or he is accidentally involved in the life cycle of the parasite. Thus, the armed tapeworm in the sexually mature state is parasitic in the human intestines, whereas in its larval stage it leads a parasitic exist-

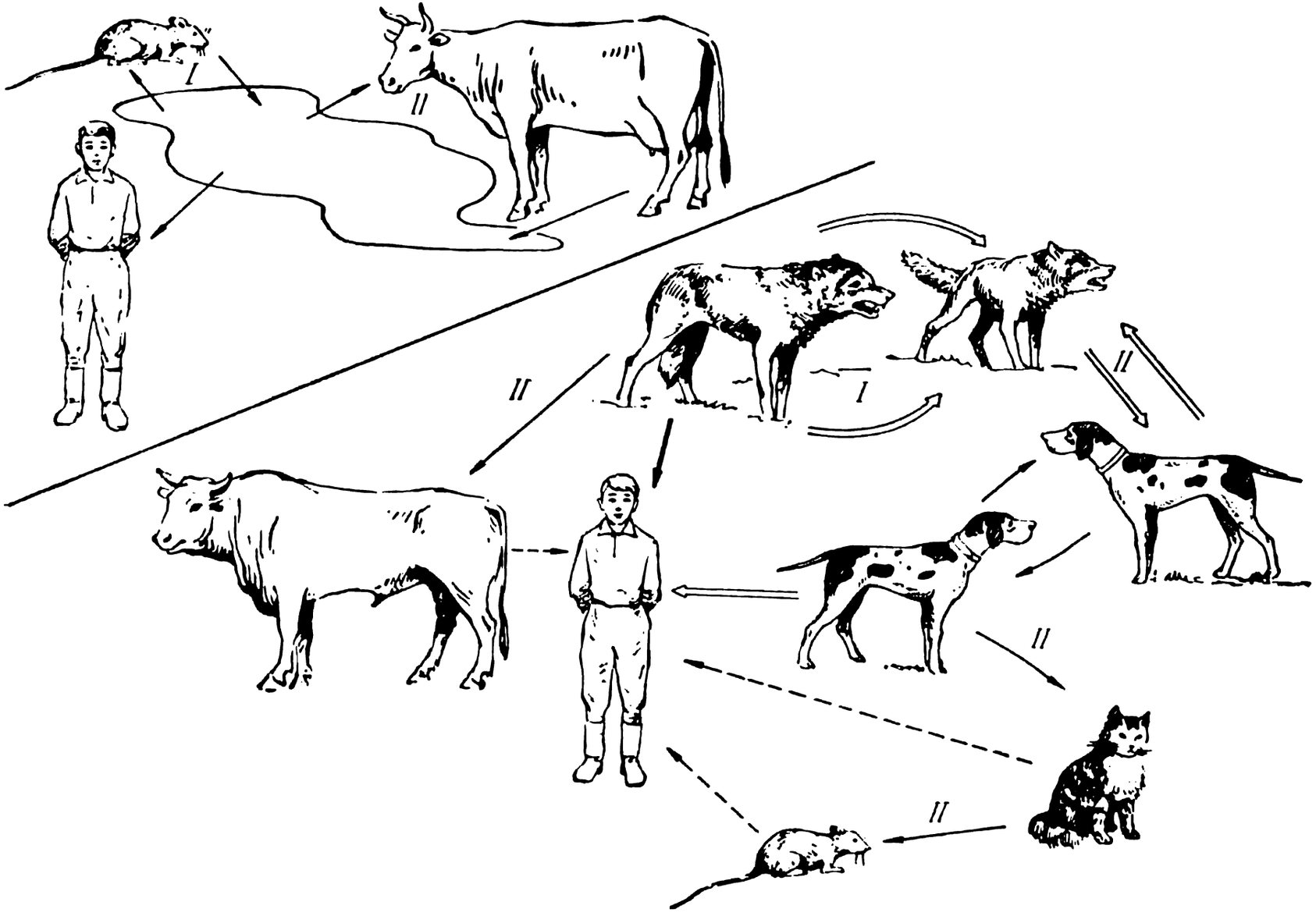


Fig. 6. The primary and secondary reservoirs in leptospirosis and rabies

I—primary, *II*—secondary reservoirs (see text); arrows—routes of circulation

ence in pigs. Here the parasite has become adapted in the course of evolution to the permanently existing food relations between men and pigs. Humans are infected by eating undercooked pork contaminated with the larvae of the worm, and pigs become infected in their turn by the eggs of the worm through contact with soil contaminated with human feces.

Still more complicated is the life cycle of the parasite in cases of opistorchosis. The sexually mature helminth is parasitic in the human organism as well as in cats, dogs, and fur-bearing animals. When the worm eggs enter the water, the larvae have two succeeding hosts, the mollusc and the fish. Humans may become infected by eating raw or undercooked fish infected with the larvae from the mollusc (Fig. 7).

The above-mentioned helminthiases are rather difficult to classify. Are we to consider the tapeworm invasion as anthroponosis or zoonosis? On the one hand, man is the sole reservoir of the adult parasite; on the other hand, he always becomes infected from the pig. We shall frequently encounter similar examples of complicated ecological relations in our studies of the epidemic process.

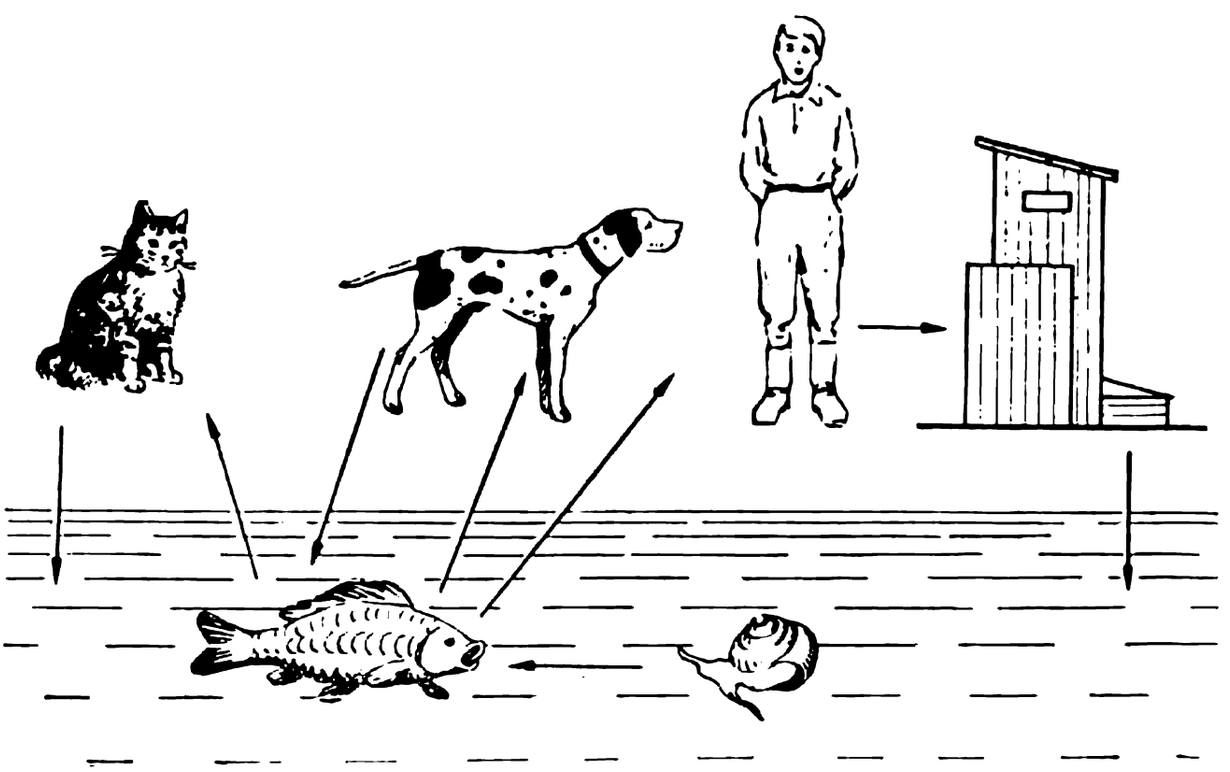


Fig. 7. The cycle of development of the cat-fluke

Factors Involved in the Transmission of the Infectious Entity. The factors involved in the transmission of the infectious entity are those elements of the environment which are instrumental in or provide for the transmission of the pathogen from a diseased to a healthy organism, while the sum total of the factors characteristic of a definite infectious disease is called the means of spreading it or *the mechanism of the transmission of the pathogen.*

Direct transmission of a pathogen from a diseased to a healthy organism occurs in few diseases. In the case of syphilis, gonorrhea and other venereal diseases, this may happen during sexual intercourse; in the case of scarlet fever or diphtheria—during kissing. Usually the pathogen travels a rather long and complicated route in the environment before it is transferred from a diseased organism to a healthy organism. Various elements in the environment can be factors involved in the transmission of the infectious entity.

Air is a factor involved in the transmission of the infectious entity in a number of infectious diseases, either by droplet or dust-borne infections.

In normal breathing the exhaled air is sterile. However, in coughing, loud talking and sneezing, huge numbers of droplets of saliva and mucous matter are expelled into the air. These droplets differ in size; and their behaviour in the air differs accordingly. Larger droplets or mucous clots expelled from the mouth or nose quickly settle on the floor of the room or on surrounding objects, etc., and seldom enter the respiratory tracts of others in the vicinity. Smaller droplets can become suspended in the air, forming an aerosol, and in accordance with the laws of physics, the smaller the size of the droplets, the longer they can remain suspended. Droplets with a diameter of 10 μ and less can be air-borne for an almost unlimited period, since they settle very slowly, moving in different directions with air currents. While in the air, the droplets partly dry and turn into so-called droplet nuclei with semiliquid contents; obviously, their diameter and weight decreases. Naturally, aerosols formed during the conversation, coughing or sneezing of a diseased person or healthy carrier, whose nasopharynx, oral cavity, bronchi and lungs are

inhabited by pathogenic microorganisms, will usually carry these microorganisms and if inhaled, they can lead to the development of an infection. It is not difficult to see that the mechanism involved in this mode of transmission of an infectious entity is highly effective since even a short stay in an infected area may lead to infection through air-borne droplets. Small wonder that the infections transmitted through the droplet method—such as measles, influenza, scarlet fever, etc.—have been called "flying" infections for a very long time. Removal of the source of infection from an enclosed space soon makes the air non-infective since the droplets disperse, are carried out of the room, etc., a process which may be expedited by simple ventilation (open doors and windows, draughts, etc.). For the same reason, the transmission of infection by this route in the open air is more difficult. Infection can be transmitted only when there is close proximity between the patient and another person.

The droplet mechanism of transmission is not characteristic of animals but is quite specific for humans. Small wonder, therefore, that infections transmitted in this manner are but for a few exceptions all anthroponoses. Because of the simplicity and effectiveness of this mechanism infections transmitted through air-borne droplets are the most widespread, namely, influenza, measles, scarlet fever and whooping cough. This also applied to smallpox and diphtheria until the introduction of prophylactic vaccination into everyday medical practice. It is also natural that these diseases are mainly confined to countries with temperate climates where people spend most of their time indoors, and to urban areas where contact is more frequent than in rural localities.

The dust-borne transmission of an infectious entity may, in the first place, occur in cases of infections transmitted by the droplet method. Dried droplets of mucous matter and sputum settled on the floor and on objects can be resuspended in the air by sweeping, shaking of bed-clothes, etc., and even by moving around the room. However, transmission of infection by means of inhaled dusty air can take place only when the pathogen is stable and withstands drying. Therefore, only a few of the infections which are trans-

mitted by the droplet way can be transmitted by the dust-borne way. Neither influenza nor measles nor whooping cough are transmitted in this manner since the pathogens of these diseases perish in the environment within the first few hours of contact. Dust-borne transmission can be observed in tuberculosis, possibly in diphtheria and scarlet fever, although the effectiveness of transmission is much less than that in the droplet method, if only because the concentration of viable pathogens in the aerosol produced by the patient or healthy carrier cannot be compared with their concentration in dust.

In certain zoonoses infection is transmitted to humans by the dust-borne mechanism. In tularemia, rodents inhabiting stacks of sheaves pollute them with their excrements. In the course of threshing, clouds of dust are raised into the air, which usually contain tremendous amounts of the pathogens of tularemia and can easily infect the threshers. In Q-fever, a rickettsial disease, infection may also be transmitted by suspended dust from straw litter polluted by cattle or rodents. Several decades ago anthrax was also transmitted in the same way, for the carcasses of domestic animals killed by this disease were frequently thrown on to refuse dumps and "rag and bone men" sometimes fell victim to this disease, known as "rag-man's disease". These examples prove that the pathogens of these diseases are resistant microorganisms that can remain viable in the environment for a long time.

Water is an important factor in the transmission of the infectious entity in numerous infections. Contamination of water with pathogens of infectious diseases may occur in various ways.

Fecal pollution of water reservoirs takes place because of faulty purification of sewage and as a result of fecal matter being carried into water reservoirs with rain-water. Pollution of water reservoirs and wells may also occur via subsoil waters (Fig. 8) if they come into contact with the contents of cesspools (latrines, etc.). Wells may be also polluted by buckets, although this can hardly be of any appreciable significance. Finally, water reservoirs can be polluted by healthy carriers bathing in them. In all the above examples, we have laid stress on the pollution of

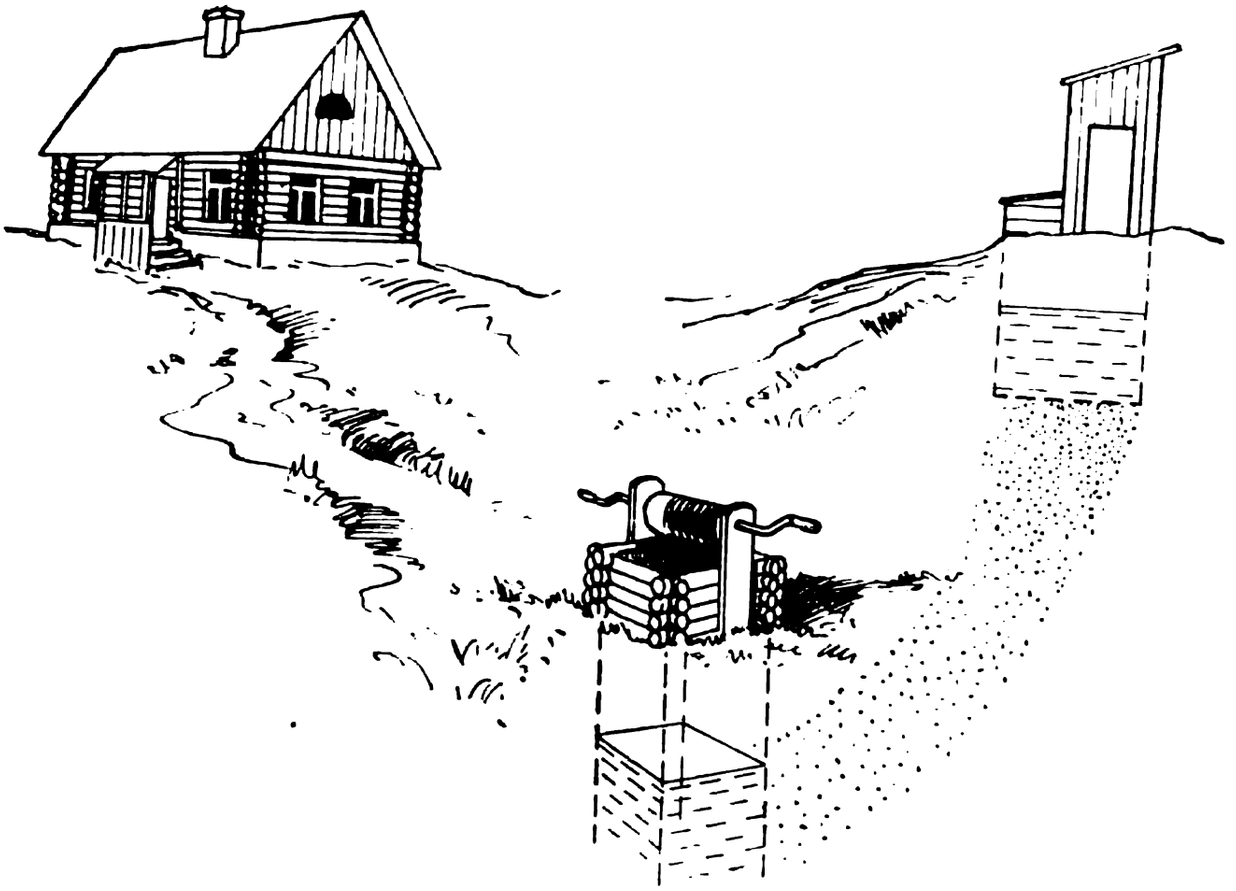


Fig. 8. Contamination of a water well by feces from a latrine with an absorbing cesspool

water reservoirs by various human excretions. Water reservoirs can be also polluted in the same way by excretions of both domestic and wild animals.

The transmission of infection by water contaminated with fecal matter occurs in cases of typhoid fever, dysentery, cholera and amoebiasis. Water-borne epidemics are extremely characteristic of the first three of these infections, when a massive fecal contamination of drinking-water reservoirs occurs within a very brief period. It leads to the infection of considerable numbers of people resulting in a high morbidity. In localities where there is a centralised water-supply system, such water-borne epidemics usually result from either technical breakdowns (e.g., a break in the sewage-collection system with drainage of the latter into the drinking-water-supply system) or violations of the rules of water-supply (e.g., link up of industrial water-supply to drinking-water mains, etc.). All of this leads to contamination of drinking-water with feces. When fecal contamination is not considerable, less explosive water-

borne epidemics may occur but they will run a more chronic course. Neither chronic nor acute water-borne epidemics occur in intestinal amoebiasis although when artificial irrigation is of a primitive nature and when water is constantly polluted by fecal matter a more or less permanently high level of amoebic infection is observed amongst the population of the area. In all the examples cited, infection is transmitted through polluted drinking-water. However, there are other routes of transmission possible through water, namely, through the mucous membranes of the eyes and nasopharyngeal cavity. For a long time trachoma was endemic in some regions of Germany due to the habit of washing in a wash-basin and not in running water. Certain forms of viral conjunctivitis are so frequently transmitted by bathing in small pools that this disease was called swimming-pool or bath-house conjunctivitis. It has been found that swimming in artificial water reservoirs and lakes often leads to adenovirus infection.

Water-borne infection is also widespread in some zoonoses (tularemia), and in others (leptospirosis) it is the major form of infection. In the case of leptospirosis, reservoirs may be contaminated by the urine of rodents inhabiting the banks of the reservoirs, or by the urine of cattle which may also serve as a reservoir of leptospirae. Humans may become infected not only by drinking this water, but also by bathing in it or during haymaking when leptospirae may enter the human organism via the mucous membranes or through injured skin.

It should be borne in mind, however, that water is not an inert storage place for pathogens. On the contrary, the biological and chemical processes taking place in rivers, lakes and reservoirs destroy certain agents of infectious diseases. These processes of auto-decontamination of reservoirs are taken into account in determining the amount of sewage which may be discharged in them.

In the case of helminthiases, besides being a direct source of infection for humans, water may also serve as a place where the pathogen undergoes a complex cycle of development changing its intermediate hosts, the inhabitants of the reservoirs. A good example is opistorchosis, when the parasite invades three consecutive hosts—man, mollusc

and fish, the latter two being inhabitants of water reservoirs. Water is contaminated with feces; humans are infected by eating raw or undercooked fish. Dracunculosis (rishta) is an example of another type of the circulation of the parasite, water acting as the factor transmitting the medium in which one of the hosts lives. The adult helminth makes its home in the subcutaneous cellular tissues of man, usually of the legs, and through the ulcerated skin the larvae are deposited by the female into the water where they are swallowed by small copepods (Cyclopes) in whose tissue they settle. Infection follows ingestion of the parasitised copepods with drinking-water. There are other types of helminth life cycles in which water serves as a medium of transmission and as the place of habitation for the intermediate hosts of the parasites.

Soil can be a medium of transmission in many infectious diseases. The soil plays an important part in the spread of infectious diseases through the medium of water, since fecal contamination of water usually occurs indirectly. First the soil is contaminated by feces and it is only later that the feces are either washed away by rain-water or reach the ground water which eventually enters sources of water-supply.

In addition, the soil is an independent factor in the transmission of infectious agents in many diseases. Amongst these diseases are wound infections (tetanus, gas-gangrene). Their pathogens enter the soil with animal or human feces and form spores which are highly stable and can remain viable in the soil for years, dying gradually as a result of the oxidising and other processes occurring in the soil. Hence the importance of the soil in transmitting the agent of anthrax to animals, which are infected and develop anthrax after grazing on fields contaminated with anthrax spores. The stability of the spore of *Bacillus anthracis* is so great that the soil in such fields remains unfit for cattle-grazing for many years.

The role of the soil in transmitting worm diseases is so great that a specific group of these diseases is called geohelminthiases. When the helminth enters the soil with the feces, it passes through a certain stage of development, either directly in the soil (ascariasis) or with the help

of intermediate hosts (teniasis). If the soil is contaminated by feces, the infection is conveyed to humans in a number of ways: per os (ascariasis), through the skin (ancylostomiasis), or by ingesting the intermediate host of the parasite (teniasis).

The food ingested by humans can also be an important factor in transmitting the infectious agent. Many species of microbes are able to survive for long periods in food; some are even capable of multiplying in it. It should be added that food rich in proteins is often a good culture media for bacteria; and viruses remain viable in a protein membrane for longer periods than in other environmental substrata.

Food can be contaminated by feces through water, soil, or directly by the hands of a diseased person or a carrier, and, finally, by the common fly. That is why diseases, transmitted by the fecal-water route, can also be transmitted by the fecal-alimentary route (Fig. 9). Furthermore, food

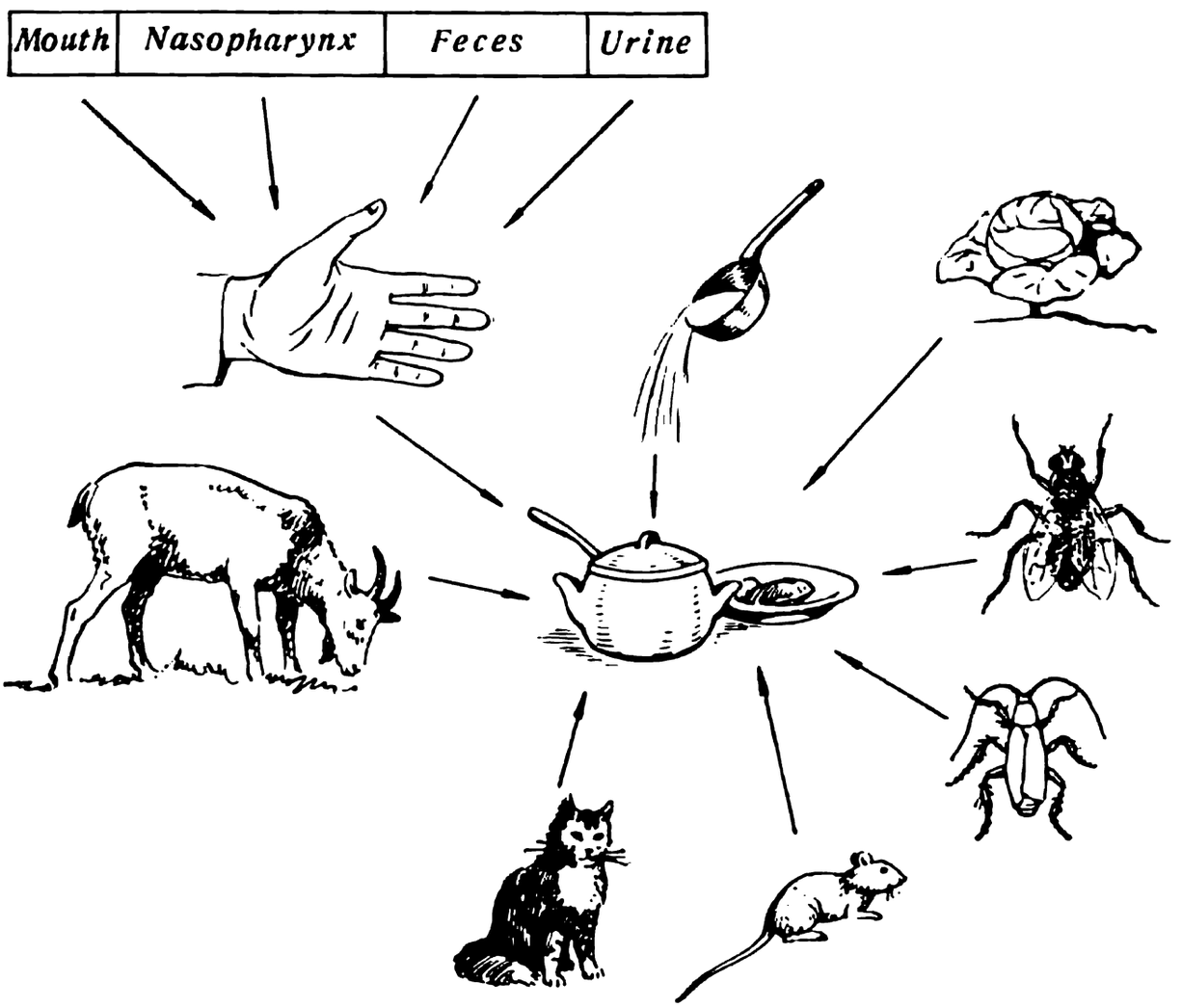


Fig. 9. Contamination of food products by agents of infectious diseases

infection is more frequent than water-borne and it would be more proper to call such diseases as typhoid fever, dysentery and cholera alimentary rather than water-borne diseases. This is also true for many geohelminthiases transmitted almost exclusively by the fecal-alimentary route. Food-borne way of transmission can also occur in scarlet fever which, as a rule, is transmitted by air-borne droplets. Although milk-borne epidemics of scarlet fever and tonsillites are rather rare, sporadic milk-borne infections are more frequent than is generally believed. The same may be said of diphtheria, tuberculosis and other air-borne diseases.

Many zoonoses are also transmitted by food. An instance of this is brucellosis, the agents of which survive for long periods in milk and dairy products obtained from sick animals. Cheese made from sheep's milk may harbour viable brucellae for one and a half or two months. Consumption of undercooked meat of animals suffering from anthrax results in infection and the development of the grave intestinal form of this disease. Plague is also known to occur after the ingestion of the meat of camels affected by this disease.

There is a group of diseases—food toxicoinfections—in which foods constitute the sole, specific factor in transmitting the infectious agent. The pathogens causing food toxicoinfections are the *Salmonellae*, relatively pathogenic bacteria of the intestinal group, *Staphylococci* and *Clostridium botulinum*. The *Salmonellae* are the agents of septic diseases in domestic animals (cattle). When infected animals are slaughtered and their meat is stored in warm premises, the *Salmonellae* multiply in the meat and toxic products accumulate. Ingestion of this meat, if insufficiently cooked, causes food toxicoinfections. Contamination of meat with *Salmonellae* may occur after the slaughtering, the bacteria finding their way into the meat from the intestines of the slaughtered animals. This can occur with improper dressing of carcasses, in processing raw and cooked meat at the same tables and during subsequent meat storage in warm rooms.

Similarly, meat and other food products may be contaminated with *Escherichia coli*, *Proteus*, or *Clostridium botuli-*

num. In the case of *Clostridium botulinum*, multiplication of the microbes is possible only under anaerobic conditions (improper salting of meat or inadequate sterilisation of canned goods). Staphylococcal toxicoinfections occur particularly frequently after ingestion of certain contaminated milk products, such as creams and other types of sweetened food.

We have already mentioned that certain types of helminths are transmitted by food. Their life cycle illustrated how subtly the parasites have adapted themselves to the food relations between man and animals, or between different species of animals. The beef tapeworm in the adult state leads a parasitic existence in the human intestines. Its eggs or, to be more exact, the larvae developed from the eggs enter the soil, are ingested by cattle together with the grass, reach muscle tissue by way of the blood and become encysted in the tissues (cysticerci). Human infection occurs after eating improperly cooked beef containing viable cysticerci. Thus breeding of cattle for meat led to the appearance of this parasite and to the disease caused by it. Opistorchosis is an example of the adaptation of a parasite to another type of food relation. The worm, which leads a parasitic existence in the intestines of man or domestic carnivora (cats, dogs), excretes its eggs into the intestinal lumen from whence they find their way to water reservoirs. The larvae develop from the eggs and enter one host and then another—fresh-water molluscs and the carp. The invading larvae settle in the tissues of these hosts. Humans, dogs and cats are infected by eating raw or insufficiently cooked fish. Naturally, this parasitic disease is widespread among people living along river banks and engaged in fishing.

Various *household articles* may also be involved in the transmission of the infectious agent. Fungous and cutaneous purulent diseases, as well as smallpox, may be transmitted by clothes. Trachoma is transmitted by the use of a common towel. The eggs of helminths are often found on door handles. The part played by household objects in air and dust-borne transmission of infectious agents has already been discussed. Utensils contaminated with the excretions of a diseased person may be a factor involved in the transmis-

sion of influenza, diphtheria, tuberculosis, syphilis and other diseases whose pathogens can be ejected through the mouth and the upper respiratory tract. Children's toys can play a similar role. Syphilis, tuberculosis and even plague have been known to be contracted after the use of a pipe previously smoked by a sick person.

The terms "contact", and "contact transmission" are frequently used in epidemiology, as well as "direct" and "indirect" contact. The term "contact", whose origin can be traced to medieval or even ancient times, is very inaccurate. Strictly speaking, only venereal and certain cutaneous diseases (excluding the transmission of certain diseases by kissing), are conveyed by direct, i.e., physical contact. The term "contact", however, is ordinarily used in a broader sense in speaking of contact transmission of measles, typhoid or typhus fever. However, in the first case we are dealing with the droplet way of transmission (measles); in the second, dirty hands are usually involved and in the third, lice. In all these examples there has been association with the patient and the word "contact" is used to stress the role of this factor in the origin of the disease. That is why it is advisable to substitute the word "association" for "contact" wherever possible. It is in this sense that the term "in contact" or "in association" should be understood when speaking of persons who have associated with the diseased patient and may be in danger of becoming infected.

Arthropoda as Vectors of Infectious Diseases. The arthropoda, living carriers of diseases, are also grouped with the factors involved in the transmission of the infectious agent. From the biological point of view the classification is incorrect, since any biological species which is a host or a parasite should be regarded as a source of infection. In the case of malaria, the mosquito is the host of the adult parasite and it is man who should be regarded as the vector rather than the mosquito. It should be remembered, however, that epidemiology is concerned with the methods of the spread of infectious diseases (pathogens) among humans. From this point of view, the arthropods, which are an element of man's environment, should be regarded as vectors of infectious diseases.

Vectors of infectious diseases of man belong to various taxonomic divisions of the arthropoda phylum within the class of insects and ticks. Most of them are blood-suckers and the infection of man or animal, or of the vector itself, is associated with blood-sucking.

Biologically vectors may be classified as mechanical and biological. The mechanical vectors are arthropoda which do not serve as the hosts of a given pathogenic parasite although the pathogen may, for certain periods, live on the surface of the body, the legs or in the intestines of the insect. In the case of typhoid fever, poliomyelitis, trachoma, etc., the mechanical vector is the common fly. Biological vectors are actual hosts of a parasite which breeds or even undergoes a certain portion of its life cycle in the host organism. The mosquito belongs to this type of vector since sporogony of the malarial plasmodium takes place in its organism. A brief description of the basic groups of pathogenic vectors is given below.

Mosquitoes are vectors of many diseases, the most important of which are malaria, mosquito-borne encephalitides, yellow fever, dengue, and a number of worm infestations (filariasis) and tularemia. Each of these diseases is transmitted by a specific group of mosquito species; hence the mosquitoes are the biological vectors of these diseases (with the possible exception of tularemia). Malaria is transmitted by mosquitoes of the *Anopheles* genus (Fig. 10); more than 100 species of mosquitoes belonging to this genus have been found to be malaria vectors, though only a few of them which feed on human blood are of significance. The most significant malaria vectors in the U.S.S.R. were the *Anopheles maculipennis* and *Anopheles sacharowi*—the latter in the southern areas. These mosquitoes breed close to human habitation and therefore are synanthropous species—a fact which explains their role in the spread of malaria. Mosquito-transmitted encephalitis, a form of which, Japanese encephalitis, occurs in the U.S.S.R., is transmitted by the *Aedes*, *Culex* and *Anopheles* genera. The *Aedes* mosquitoes are also vectors of yellow fever and dengue.

Since the *Aedes aegypti* is a synanthropous species, the spread of these two diseases beyond their original nidi is associated with the migration of the mosquito concerned.

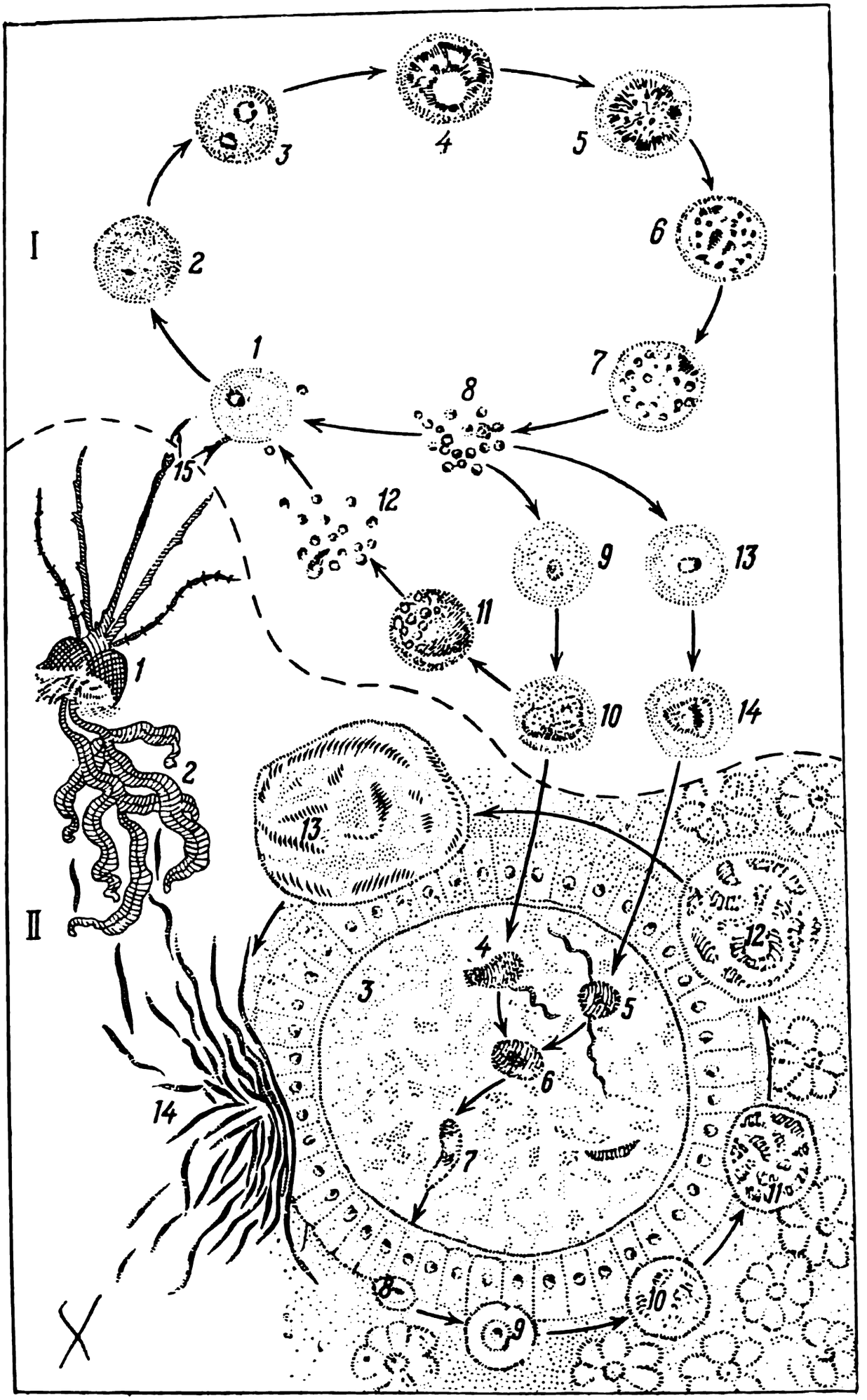


Fig. 10

Mosquitoes of the *Aedes* and *Culex* genera can transmit tularemia. Finally, the genera of *Anopheles*, *Aedes*, *Mansonia* and *Culex* are vectors of filariae (wuchereriasis, loasis), whose larvae undergo their development cycle within the body of the mosquito. Ordinarily, the mechanism of infection of man by mosquitoes is as follows: at the moment of the bite, the pathogenic agents in the salivary glands of the mosquito enter the wound with the saliva and eventually pass into the blood. In the case of filariasis, the filarial larvae, which are in the proboscis of the mosquito, rupture the membrane of the proboscis at the moment of biting, are deposited on the surface of the skin and penetrate to the blood vessels. In tularemia it is most probable that a purely mechanical transfer of bacteria by the biting apparatus occurs.

The *Phlebotomus* sandflies transmit Pappataci fever (sandfly fever), bartonelosis (Oroya fever) and numerous forms of skin and visceral leishmaniases, widespread in both the Old and New Worlds. These sandflies are the biological vectors of the pathogens. of these diseases. Infection occurs through the bite of the mosquito.

Gnats of the *Simulium* genus transmit certain filariases, being intermediate hosts of respective helminths. The mechanism of infection is the same as in the transmission of filariases by mosquitoes.

Fig. 10. The cycle of development of the malarial plasmodium (after S. D. Moshkovsky)

I—asexual development in man's organism: *1*—erythrocyte with the young schizont; below on the left-hand side two sporozoites are approaching the erythrocyte, two merozoites are approaching it from the right-hand side; *2*, *3*, *4*—the development of the schizont in the erythrocyte; *3*—two parasites in an erythrocyte, one of the parasites possesses two nuclei; *4*—the big ring phase; the pigment grains can be seen in its enlarged part; *5*—adult schizont; *6*, *7*—schizont in the stage of segmentation; *8*—free merozoites following the break-up of the erythrocyte, ready for fresh infection; *9*, *13*—some of the merozoites following implantation in the erythrocyte give rise to the formation of sexual forms (young macro- and microgametocytes); *10*, *14*—sexually mature macro- and microgametocytes; *11*, *12*—inverse development of a microgametocyte into merozoites. *II*—sexual development in the body of a mosquito: *1*—the head; *2*—the salivary glands; *3*—the stomach; *4*—macrogamete and *5*—microgametocyte in the stomach of a mosquito, liberated from the erythrocytes; a microgametocyte separates several flagella—spermatozoites, one of which copulates with the macrogamete; *6*—the young fertilised cell; *7*—ookinete; *8*—oocyst; *9*, *10*, *11*, *12*, *13*—the oocyst in different stages of maturing; *14*—the rupture of the mature oocyst with the liberation of the sporozoites; the latter invade the salivary glands of the mosquito wherefrom, together with the saliva of the insect, they enter the blood of man during the bite; *15*—two sporozoites which entered man's blood are approaching an erythrocyte

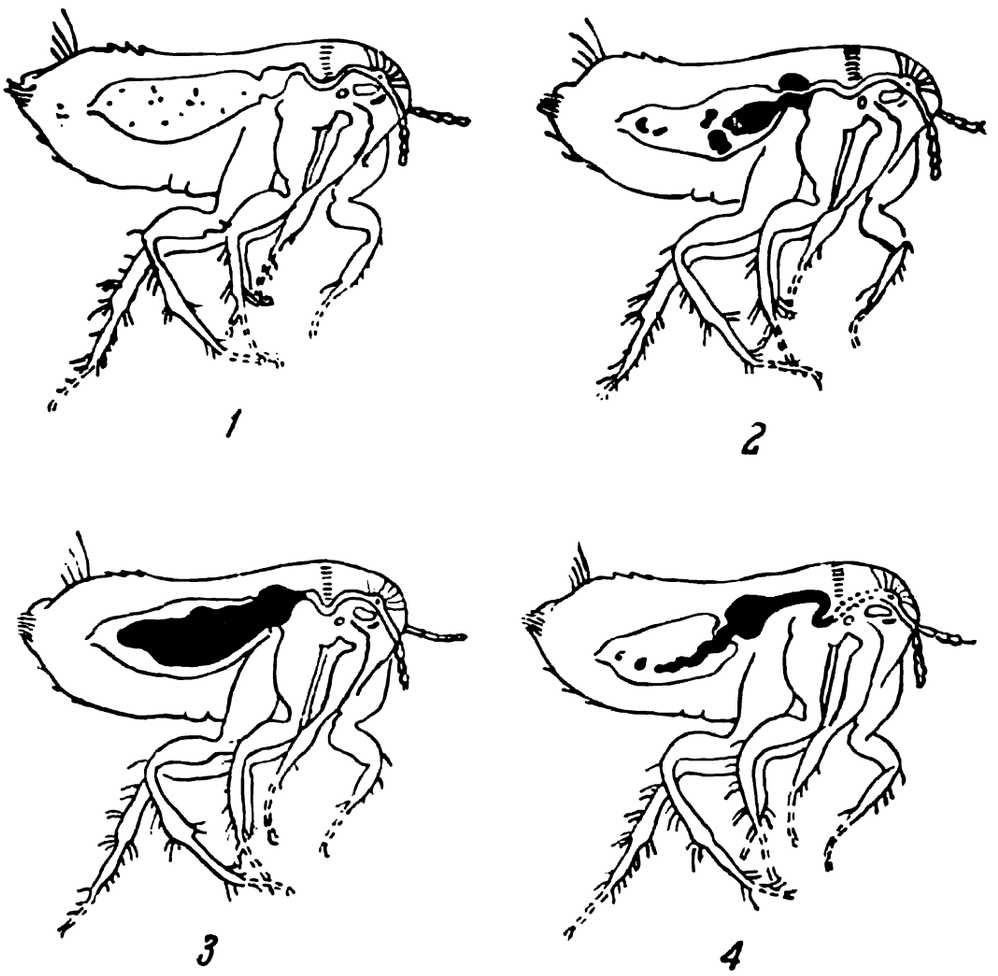


Fig. 11. The process of formation of a "plague block" in a flea (by V. N. Fyodorov and I. I. Rogozin)

Blood-sucking flies are vectors of tularemia, filariases, anthrax and trypanosomiasis. In the U.S.S.R., *Chrysops discalis*—the deer-fly—is a mechanical vector of anthrax, while other representatives of this genus are vectors and intermediate hosts in filariasis. The deer-fly, (*Chrysops discalis*), and the biting fly, *Stomoxys calcitrans*, transmit tularemia. Tsetse flies (*Glossina* genus) are the vectors of African sleeping sickness (trypanosomiasis).

Fleas transmit plague, rat rickettsiosis and also the rat and the pumpkin tapeworm. The numerous species of fleas belonging to the genera *Ceratophyllus*, *Xenopsylla* and others, as well as the common flea, *Pulex irritans*, are involved in the dissemination of plague in nature and infect man with plague. The infection occurs during biting. Plague bacteria accumulate in the gastric tract of a flea and are regurgitated into the wound where the flea bites (Fig. 11). Infection with rat rickettsiosis does not occur during the

flea's bite but as a result of post-bite itching, when flea feces containing rickettsias is rubbed into the skin. Infection with rat and dog tapeworm occurs as a result of swallowing fleas or their larvae containing the cysticercoid. This mechanism of transmission, usual in dogs and rodents, is naturally rarely met with in man but it can occur—e.g., the accidental swallowing of a flea by a baby.

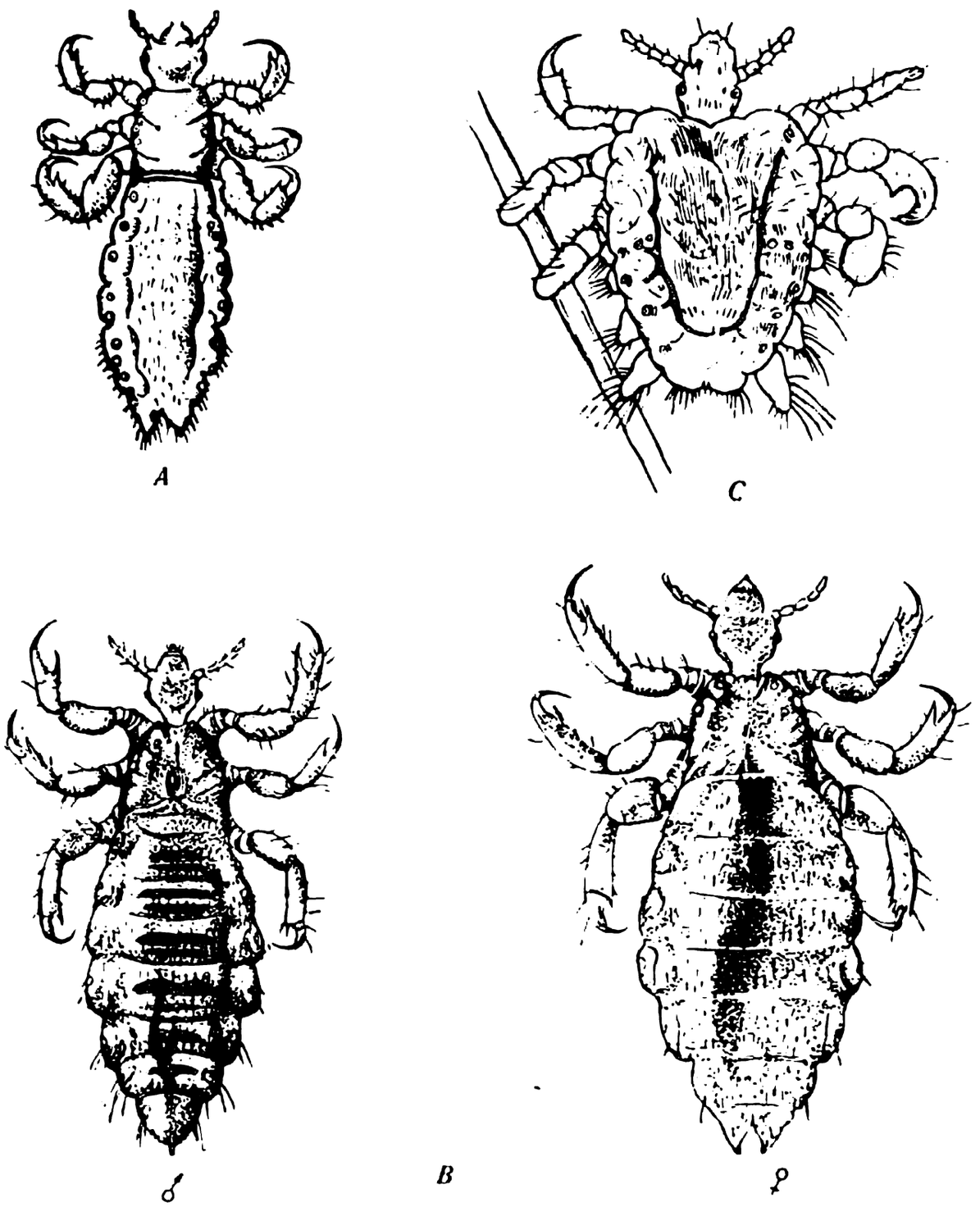


Fig. 12. Lice (after V. N. Beklemishev)

A—body louse (*Pediculus humanus corporis*); *B*—head louse (*Pediculus humanus capitis*). Male and female greatly magnified; *C*—pubic louse (*Phthirius pubis*)

The *Pediculus humanus* (Fig. 12), specifically, the body louse, is the vector of typhus fever and relapsing fever. The transmission mechanisms of these infections differ. *Rickettsiae prowazeki* develop in the intestinal epithelium and are deposited on human skin together with the feces of the louse. Infection takes place when the feces is rubbed into the skin by scratching the itching bitten area. *Spirohaetae obermeieri (Borrelia recurrentis)* invade the body of a louse. Infection occurs when the hemolymph of a crushed or injured louse containing the spirohetes is rubbed in. Lice are a strictly specialised species and therefore the numerous species of lice which live on wild and domestic animals, transmitting various diseases to them, do not attack man.

Bedbugs do not transmit any diseases. Certain species of bugs, however, are of epidemiological significance: "the kissing bug", *Triatoma megista*, and other biting bugs of this genus transmit *Trypanosoma cruzi*, the pathogenic agent of South American trypanosomiasis (Chagas' disease).

Among other insects, flies including the common fly, *Musca domestica* (Fig. 13), are of undoubtedly great epidemiological significance. The common fly, a synanthropous insect, is an important carrier of typhoid, dysentery, poliomyelitis and other diseases transmitted by the fecal-alimentary route, and also of diseases such as tuberculosis, tra-

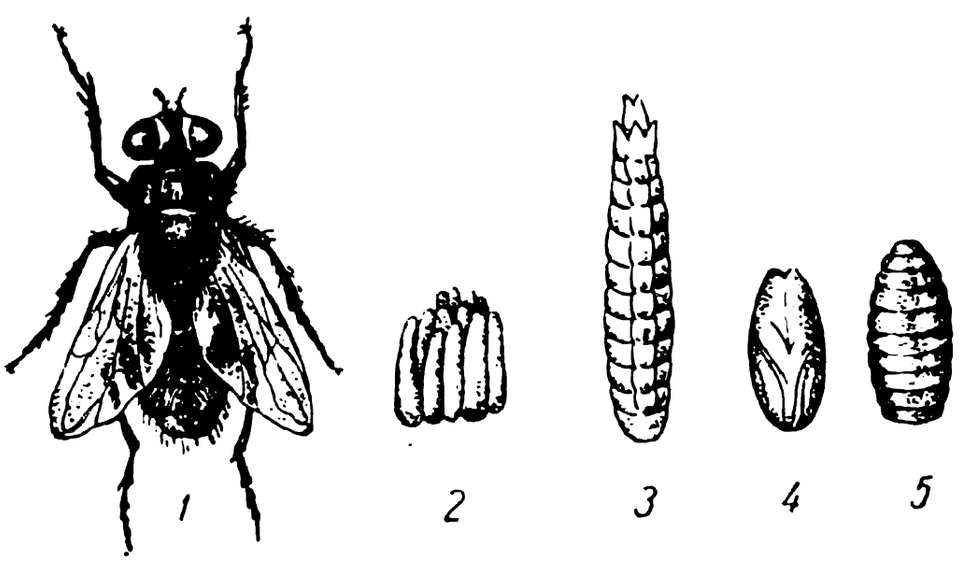


Fig. 13. The cycle of development of a house fly (after V. N. Beklemishev)

1—house fly; *2*—eggs of a house fly; *3*—adult larva; *4*—pupa; *5*—cocoon of a house fly

choma, diphtheria, etc. The part played by the fly as a mechanical carrier is determined by the specific features of the fly's biology—hatching in sewage and waste, it is in constant contact with feces and other excreta, on the one hand, and with food, skin and the mucous membranes, on the other. The extent and rapidity with which flies multiply in favourable conditions explain the exceptional significance of this insect in the transmission of many infectious diseases of man.

Among other insects cockroaches are of some epidemiological significance. They are intermediate hosts of certain helminths (*Gongylonema*), with which man may be infected in rare cases (e.g., the swallowing of a cockroach by a baby).

Numerous species of ticks are vectors of many infectious diseases: tick-borne spirochetoses (recurrent fevers), tularemia, tick-borne rickettsioses, tick-borne encephalitides, hemorrhagic fevers, equine encephalitides and other diseases, including certain helminthiases (Fig. 14). Ticks are biological vectors since the pathogenic agent not only multiplies or develops in their organism but in many cases is hereditarily transmitted to the egg. This is why ticks constitute the main and, most probably, the primary reservoir of pathogens in tick-borne encephalitides, rickettsioses and recurrent fevers. Amongst the many ticks, certain groups are associated with specific infectious diseases. Ticks of the *Ornithodorus* genus are vectors of recurrent fevers (spirochetoses) whose natural foci are found almost all over the world. The *Ixodidae* ticks belonging to genera *Dermacentor*, *Amblyomma*, *Haemaphysalis* and *Rhipicephalus* transmit the exanthematous fevers of the Old and New Worlds; vectors of the tick-borne encephalitides belong to the *Ixodides*, *Dermacentor* and *Haemaphysalis* genera; vectors of hemorrhagic fevers are ticks belonging to the *Dermacentor* and *Hyalomma* genera. The equine encephalomyelites of America are also transmitted by the *Ixodidae* ticks of the *Dermacentor* genus. Gamasoid ticks are vectors of vesicular rickettsiosis (gen. *Allodermanysus*), Far Eastern hemorrhagic fever (gen. *Laelaps*) and lymphocytic choriomeningitis, and in addition, are involved in the transmission of American St. Louis encephalitis and tularemia.

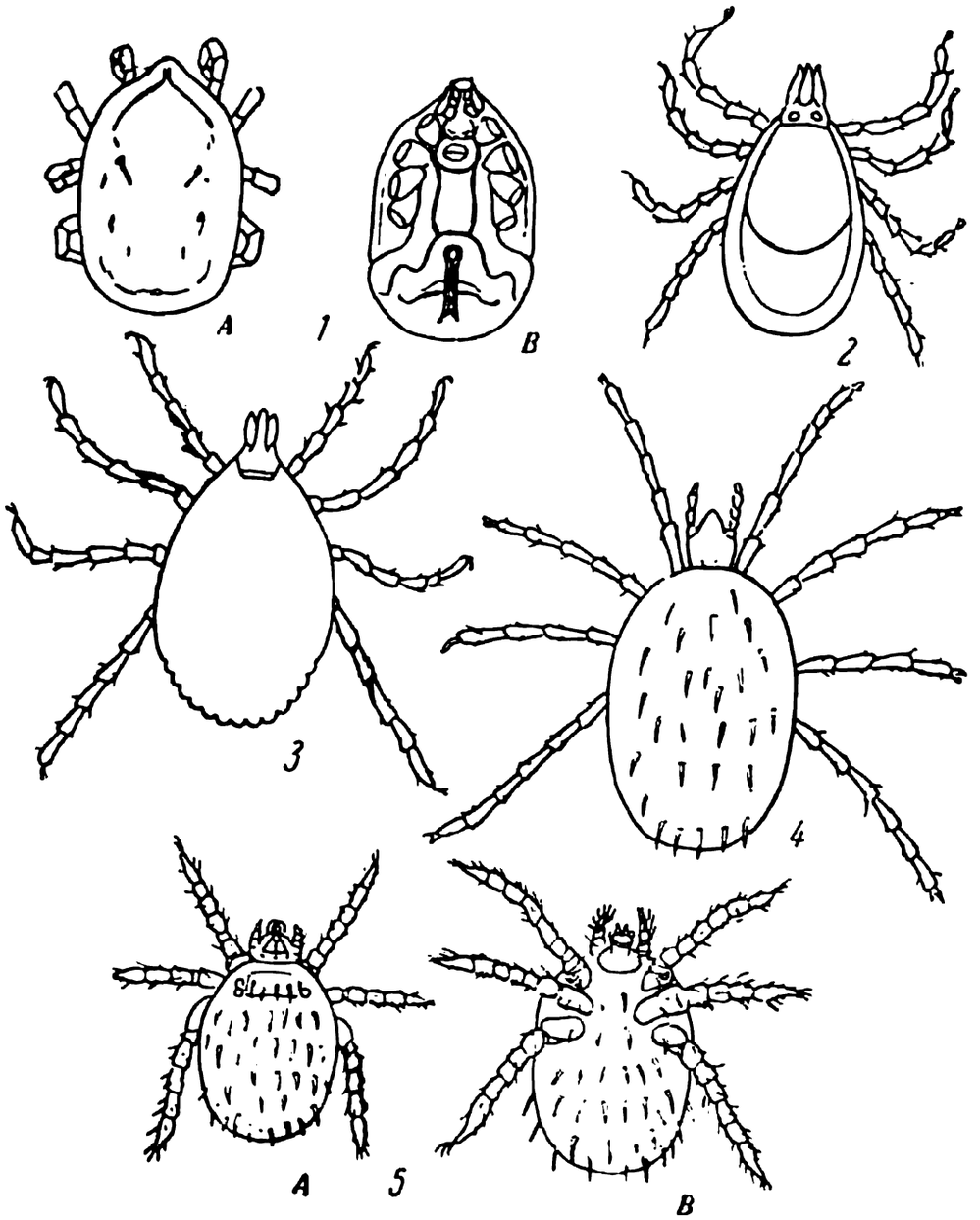


Fig. 14. Several species of ticks—vectors of infectious diseases (after V. N. Beklemishev)

1—Alectorobius tholozani papillipes: *A*—female (from above), *B*—female (from below); *2—Ixodes persulcatus*; *3—Hyalomma marginatum*; *4—Allodermanyssus sanguineus*; *5—Trombicula akamushi*: *A*—larva (from above), *B*—larva (from below) (greatly magnified)

Trombicula ticks, blood-suckers only in the larval stage, transmit the tsutsugamushi fever and other varieties of this rickettsiosis.

It may be seen from the foregoing that in some diseases, the vector is a single species of arthropoda (the louse, for instance, in typhus fever); in others, there are several related species (for instance, the *Anopheles* mosquitoes in malaria); and in still other cases, the disease may have

many vectors belonging to different taxonomic groups (for instance, the *Ixodidae* ticks, the *Triatoma* bugs and mosquitoes in American equine encephalomyelites).

The Mechanism of Transmission and the Classification of Infectious Diseases. In the epidemic process the most important link responsible for the existence of an infectious disease is the mechanism by which it is transmitted, since the mechanism of transmission perpetuates the causative agent of the infectious disease, the parasite, as a biological species. Without this mechanism, there would be no infectious disease.

The mechanism of transmission, the pathogenesis of the disease and the biological properties of the causative agent are very closely interrelated. The following examples will illustrate this.

Measles is transmitted by the droplet method. The portal of entry is the respiratory tract which is also the site of discharge of the virus from the organism. The pathogenesis of measles, however, is far from being exhausted by ailments of the respiratory tract. The virus of measles has little resistance and is easily destroyed in the environment. In this case, the pathogenesis of the infection and the mechanism of transmission form a single entity. The ease with which the disease is transmitted makes it unnecessary for the pathogen to develop an ability to withstand unfavourable environmental conditions.

In typhoid (enteric) fever, the pathogen enters and leaves the organism through the intestines, although disturbances in the latter exhaust the pathogenesis of typhoid even less than the disturbances in the respiratory tract exhaust the pathogenesis of measles. Factors in transmission may be water, soil, food, flies and all other elements of association in the home. In short, the pathogen enters the mouth either with food or water, or is simply carried there by dirty hands. It is clear that the pathogen travels a rather long way in the environment before it is transferred from a diseased patient (or carrier) to a healthy person. This explains the comparatively high stability of the typhoid-fever pathogen.

In typhus fever, *Rickettsia prowazeki* is transmitted by lice. The prolonged rickettsiemia, responsible for the infection of a louse during blood-sucking, is of decisive sig-

nificance in the pathogenesis of typhus. As for rickettsias, they have developed an ability to multiply in such different media as the endothelium of the blood vessels of man and the endothelium of the intestines of a louse.

Drawing attention to the interrelationship between the properties of the causative agent, the pathogenesis of infection and the mechanism of transmission, L. V. Gromashevsky suggested that we define the specific localisation of infection (or more correctly of the agent) in an organism as the one which is associated with the mechanism of transmission. For instance, tick-borne encephalitis causes viremia and disturbances of the central nervous system; in this case, the blood and not the nervous system is the specific localisation of the parasite, since the vector is infected by means of the blood. The specific localisation of the causative agent in the organism and the pathological process resulting there may or may not coincide with the localisation of the agent producing the principal manifestations of the infection concerned. In influenza, both localisations coincide, whereas in poliomyelitis this is not the case. The specific localisation of the pathogen is the intestines, but the principal clinical manifestations of poliomyelitis—paralyses—are associated with the multiplication of the virus in the anterior horns of the spinal cord.

A study of the mechanism involved in the transmission of infection has made possible a classification of infectious diseases based on epidemiological principles (Fig. 15 *a-d*).

No other principles are applicable in epidemiology. For instance, if the etiological principle were to be used, we would be obliged to include meningitis and gonorrhea (gram-negative cocci) in one group; relapsing fever, leptospiral jaundice and syphilis (spirochetes), etc., in another group. The etiological classification is inapplicable because the causative agent of an infectious disease and the disease itself are two quite different things. In epidemiology the classifications based on clinical manifestations are also impracticable, since in this case we would have to class typhoid fever, measles and typhus fever in a group of exanthematous fevers; poliomyelitis and tick-borne encephalitis —in a group of neuroinfections, etc.

That etiological or clinical classifications are inapplicable in epidemiology does not at all mean that these classifications are faulty in general. Etiological classification is just as indispensable for a microbiologist as clinical classification is for a specialist in infectious diseases—if only for purposes of diagnosis.

Epidemiological classifications are all more or less similar, since they are based on the mechanism of transmission or the routes of spread of infectious diseases. It has been shown above that the mechanism of transmission is related to the pathogenesis of the infection, including the specific localisation of the pathogen, as well as to the biological properties of the pathogen. With the mechanism of transmission used as the basis the majority of infectious diseases can be subdivided into four basic groups (Table 1).

Table 1

Classification of Infectious Diseases of Man

Groups	Subgroups	Typical Examples
I. Intestinal infections (alimentary infectious diseases)	A. Anthroponoses	Typhoid fever
	B. Zoonoses	Salmonellosis
II. Infections of the respiratory tracts (droplet infectious diseases)	A. Anthroponoses	Influenza
	B. Zoonoses	Ornithosis
III. Infections of the external tegumen (diseases transmitted via the external tegumen without the mediation of living vectors)	A. Skin diseases	Favus
	B. Zoonoses	Anthrax
	C. Wound infections	Tetanus
	D. Diseases caused by bites of animals	Rabies
	E. Venereal diseases	Gonorrhea
	F. Eye diseases	Trachoma
	G. Diseases of the mucosa of the mouth	Herpes
IV. Infections of the blood (transmissive infectious diseases)	A. Anthroponoses	Typhus-fever
	B. Zoonoses	Tick-borne rickettsioses

I. Intestinal infections or alimentary infectious diseases. The causative agent is discharged in the feces or the urine. Factors in transmission may be food, water, soil, flies, household articles, dirty hands. Contagion occurs through

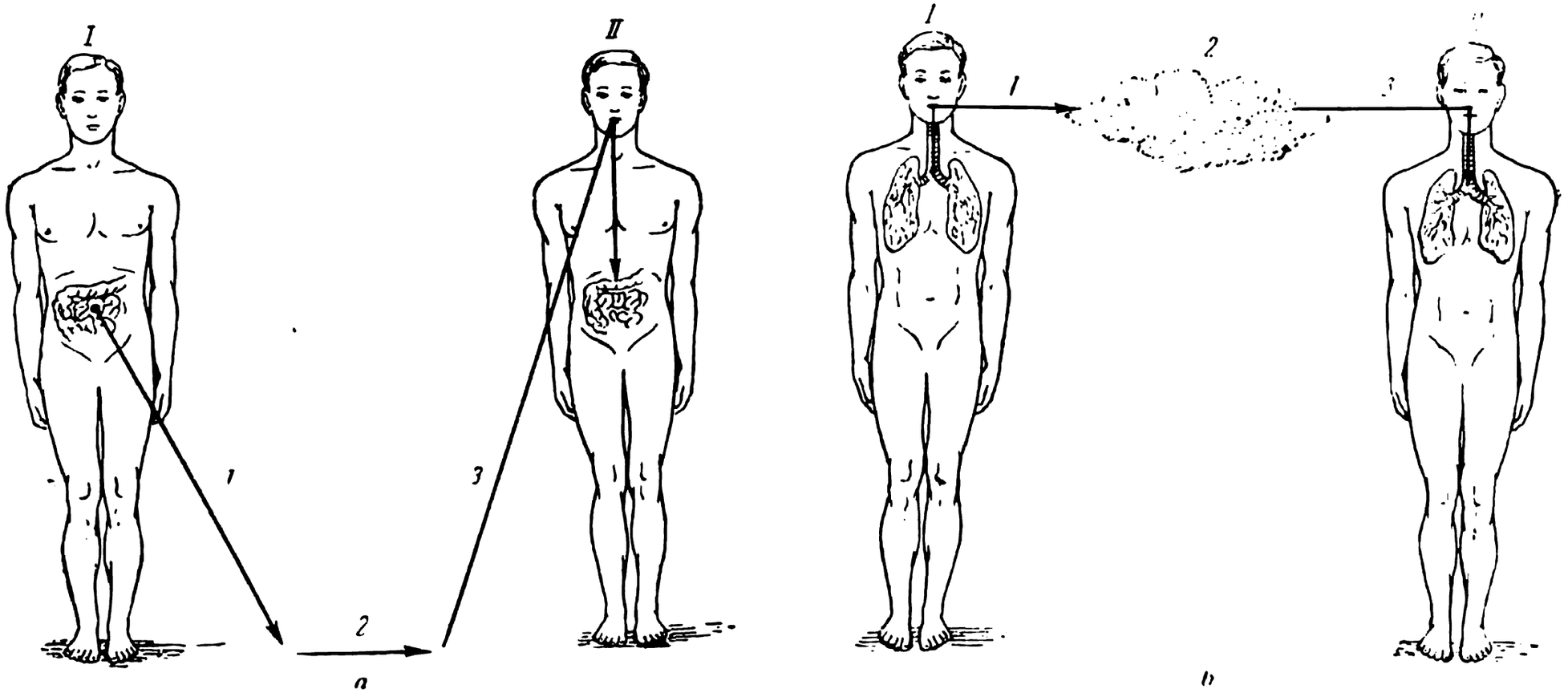


Fig. 15a, b. Routes of transmission of four groups of infectious diseases (after L. V. Gromashevsky)

a—routes of transmission of the infectious entity in intestinal infections: *I*—infected organism; *II*—healthy organism: *1*—the shedding of the agent (defecation); *2*—the transmission of infection in environment (flies, hands, water, food products); *3*—the introduction of the pathogenic agent (per os with infected food or drink); *b*—ways of transmission of the infectious entity in respiratory infections: *I*—infected organism; *II*—healthy organism, *1*—shedding of the agent (exhalation); *2*—the presence of the pathogenic agent in the air (droplet infection); *3*—introduction of the causative agent (inhalation)

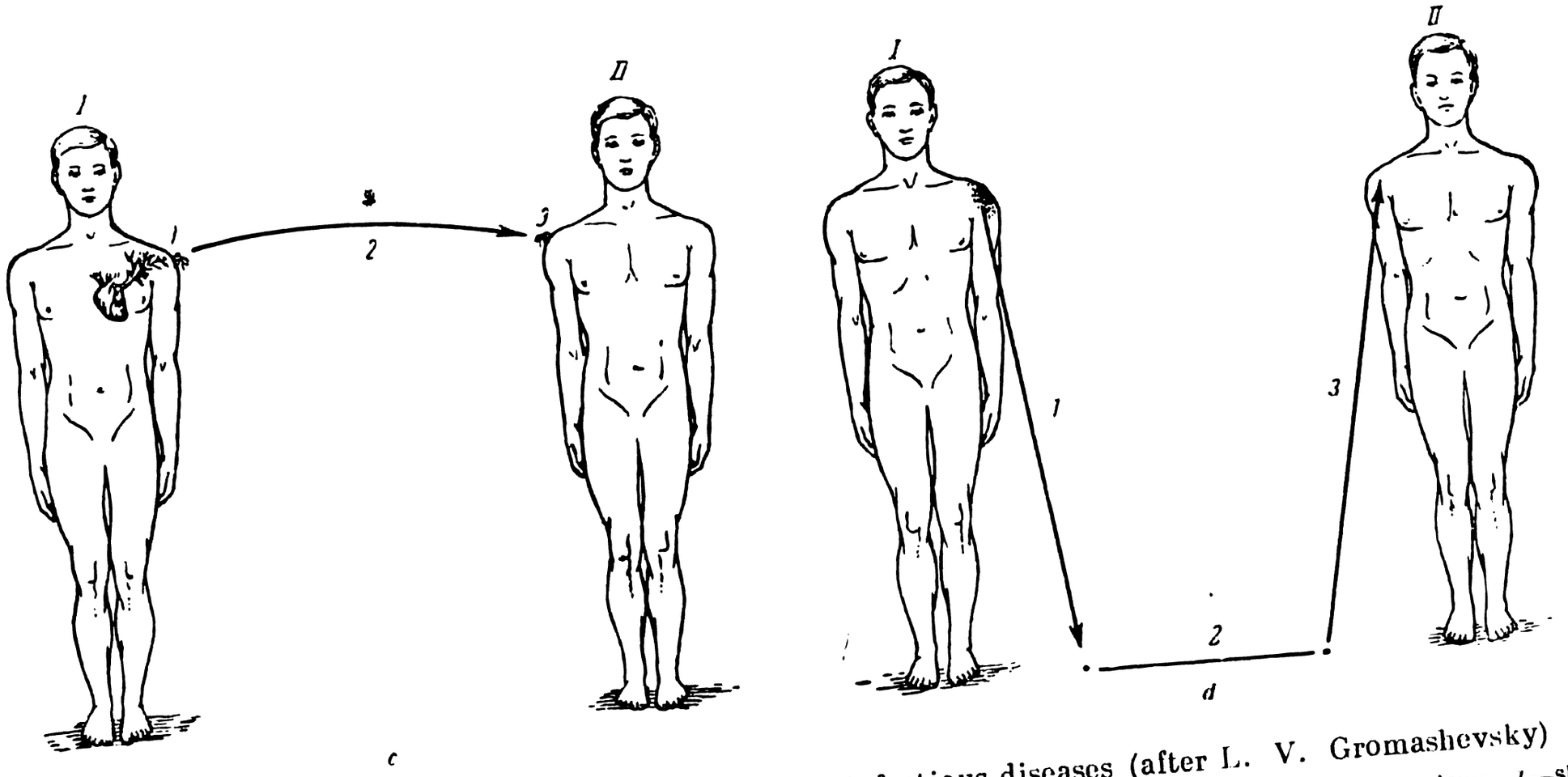


Fig. 15c, d. Routes of transmission of four groups of infectious diseases (after L. V. Gromashevsky)

c—routes of transmission of the infectious entity in blood infections: *I*—infected organism; *II*—healthy organism: *1*—shedding of the agent (blood-sucking by the arthropoda vector); *2*—the presence of the agent in environment (in the organism of the carrier); *3*—introduction of the pathogenic agent (inoculation when the carrier bites a healthy man)

d—routes of transmission of the infectious entity in infections of the external tegumen: *I*—infected organism; *II*—healthy organism: *1*—shedding of the agent (with pathologic products of infected tissues); *2*—the presence of the agent in environment (on various objects); *3*—introduction of the pathogenic agent (contact with external tegumen or introduction in a wound)

the mouth. Typhoid fever is a typical example of this infection.

The diseases of this group can be divided into two subgroups according to the source of infection (reservoir of the pathogen): anthroponoses and zoonoses.

The anthroponoses include typhoid and paratyphoid fevers, dysentery and infectious enterocolites (colienterites, viral diarrhea), cholera, amoebiasis (amoebic dysentery) and protozoal colites (lambliasis, trichomoniasis), infective hepatitis, poliomyelitis and diseases caused by intestinal viruses (ECHO, Coxsackie), many varieties of geohelminthiases (ascariasis, trichocephaliasis, trichiniasis, enterobiasis) and biohelminthiases (teniases, hymenolepiases, dipylidiasis, diphyllobothriases, opistorchosis, fascioliasis, dicroceliasis, metagonimiasis, paragonimiasis).

The zoonoses include salmonelloses, botulism, brucellosis, leptospiroses, balantidiasis, coccidioses. The above-mentioned biohelminthiases, which man contracts when eating raw or undercooked meat or fish, and intestinal myiases could also be classed with this subgroup.

II. Infections of the respiratory tracts, or the droplet infectious diseases. The causative agent is discharged with the secretion of the respiratory tracts or the mouth cavity. The factor of transmission is air and less often, household objects. Infection takes place by the droplet or the dust-borne methods, less often by the use of tableware, toys and other objects contaminated by the diseased person or carrier. Influenza is a typical example of this infection.

The diseases of this group include whooping cough, diphtheria, scarlet fever and anginas, epidemic cerebrospinal meningitis, pneumonias (bacterial, protozoal, viral), influenza and similar diseases, adenoviral diseases, common cold, bacterial catarrhs of the respiratory tracts, etc., tuberculosis, leprosy, ozena, scleroma, smallpox, measles, chickenpox, epidemic parotitis, lethargic encephalitis, herpes, rubeola scarlatinosa and German measles, ornithosis, psittacosis, and also certain fungoid lesions of the respiratory tracts. All these diseases are anthroponoses with the exception of ornithosis, psittacosis and some other forms of fungoid lesions of the respiratory tracts which are transmitted to man by birds.

III. Infections of the external tegumen, or diseases transmitted via the external tegumen (without the mediation of living vectors).

The diversity of external tegumen (skin, hair, mucous membranes of the eyes, the urogenital tracts, mouth and nasopharyngeal cavities) is responsible for a considerable number of subgroups in this group of diseases, apart from the division into the anthroponoses and the zoonoses. There are the following subgroups:

A. Skin diseases: streptococcal and staphylococcal pyodermas, yaws, pinta, pemphigus, psoriasis, warts, molluscum contagiosum and many other viral dermatoses, epidermophytoses, favus, trichophytoses, microsporosis and other forms of dermatomycoses, deep and systemic mycoses, scab and certain forms of myiases.

With the exception of several mycoses of zoonotic origins, the diseases listed are anthroponoses. The mycoses of zoonotic origin are more akin to the next subgroup.

B. Zoonoses transmitted via the skin: anthrax, glanders, melioidosis, erysipeloid, pasteurellosis, listerellosis, foot-and-mouth disease, cowpox (vaccinia) and paravaccinia.

C. Wound infections: tetanus, gas-gangrene, erysipelas.

The common feature in the three subgrouos enumerated is that the portal of entry is the skin. Certain worm invasions should also be classed with them: ancylostomiasis, strongyloidiasis, schistosomiases which are initiated by active implantation of the helminth larvae in the skin, from which they reach the blood stream and subsequently settle in the intestines, the urinary tracts or the blood vessels.

D. Diseases caused by bites of animals: rabies, sodoku. Haverhill fever, lymphoreticulosis (a disease caused by a cat bite or scratch).

E. Venereal diseases: syphilis, gonorrhea, soft chancre, inguinal granuloma. The diseases of the urogenital tracts also belong to this group: non-suppurative (non-specific) urethrites, Reiter's syndrome, trichomoniasis of the genitals, condylomae acuminatum.

F. Eye diseases: trachoma, bacterial and viral conjunctivites.

G. Diseases of the mucous membrane of the mouth: fusospirochetoses, herpetic infection, bacterial and viral sto-

matites, yeast mycoses and other fungous diseases of the mouth cavity.

IV. Infections of the blood or transmissive infectious diseases. This group of diseases, as can be seen from its name, is transmitted by blood-sucking vectors. Here, too, the subgroups of anthroponoses and zoonoses can be distinguished.

The anthroponoses include typhus fever, relapsing fever, bartonellosis, malaria, several forms of cutaneous and visceral leishmaniasis, yellow fever, dengue, Pappataci fever, filariases.

The zoonoses include tick-borne spirochetoses (relapsing fevers), plague, tularemia, tripanosomiases, most forms of cutaneous and visceral leishmaniasis, rickettsioses, tick-borne encephalitis, hemorrhagic fevers, mosquito encephalites, American encephalomyelites, a number of tropical fevers of viral etiology.

A closer examination of the diseases enumerated will reveal that there are some with several mechanisms of transmission. For instance, plague and tularemia have been classed with the group of transmissive zoonoses, as in this case consideration had to be given to the basic type of the pathogen's circulation in nature. In actual fact man can become infected with plague not only by fleas (bubonic plague), but by the alimentary route (intestinal form of plague), and plague can be spread among people by the droplet infection (pneumonic plague). Tularemia can be transmitted by the bite of a blood-sucking arthropoda, via skin lesions, and by the alimentary and the droplet way. Hence, plague may be classed with groups I, II and IV, and tularemia with any or all of the four groups. Diphtheria is transmitted by droplet infection, but there is also diphtheria of wounds. The list of such examples could be extended considerably (anthrax, leptospiroses, a number of worm intestations, etc.). Obviously any classification is only a conventional division which can by no means be compared with the variety found in life. However, the fact that there are diseases which have several mechanisms for transmitting the pathogenic organism does not contradict the classification suggested, since in the main (possibly with the exception of a few helminthiases) these are reduced to the

aforementioned four mechanisms of transmission or are variants thereof.

At the same time this classification of infectious diseases is of more than theoretical and informative importance; it has a practical application, making it possible to group anti-epidemic and prophylactic measures launched against several diseases at once. It is in this sense that the action of a certain measure or of a number of measures against several infectious diseases is meant when we speak of measures directed against intestinal infections, louse-borne diseases and venereal disease. For instance, if effective fly-control measures are undertaken, this means that we are at the same time taking action against typhoid fever, dysentery and infective hepatitis. The eradication of prostitution in our country led to a drop in syphilis, gonorrhea and other venereal diseases.

The control pediculosis is also an effective measure against typhus fever, relapsing fever and trench fever. However, it is hard to find a common control measure to combat dysentery and tick-borne encephalitis or malaria and brucellosis. This proves that the rational classification of infectious diseases stands up well to the basic criterion of its validity—namely, its application in practice.

Susceptibility and Immunity. The existence of sources of infection, and also of various transmissive factors of an infectious nature characteristic of a given illness, can only lead to an outbreak of the disease, i.e., to completion of the epidemic chain in the presence of susceptibles.

People vary considerably in their susceptibility to infectious diseases. But there is a number of diseases to which man is universally susceptible. Thus infection with typhus fever or measles, provided a person has not suffered from it previously, always results in the development of a clinically manifested disease. With other infectious diseases susceptibility may be incomplete, so that only a part of those infected become ill, whereas the others are infected asymptomatically and become healthy carriers. This phenomenon is characteristic of scarlet fever, which affects approximately 40 per cent of those infected, and of diphtheria, to which approximately 20 per cent of those who have not suffered from it previously are susceptible. These values

are usually called the contagiocity indices and are derived from the data obtained from analysis of epidemics over a number of years. In still other diseases, only a small proportion of those infected become ill, while in the majority of cases the infectious process takes an asymptomatic form. Highly indicative in this respect is poliomyelitis. Out of 100 infected persons, on the average one or two develop the paralytic form, five or six develop a mild form without paralysis and the remaining 92 or 94 have an asymptomatic infection. All three forms of the infectious process—paralytic, non-paralytic and asymptomatic—lead to the development of immunity. Consequently, most children in modern urban communities become immune to poliomyelitis between eight and twelve years of age, if not earlier.

This variation in susceptibility explains why in the case of measles the morbidity assumes the nature of an outbreak where the connecting links between isolated cases are easily traceable, whereas the epidemic process in poliomyelitis appears as a number of unrelated sporadic cases, whose connecting links are the non-paralytic and asymptomatic forms of the disease, which are extremely difficult to diagnose.

The intensity and duration of immunity also varies with different infectious diseases. The first attack of measles and smallpox gives a lasting, almost always life-long immunity and reinfection is practically excluded. An attack of influenza results in an intensive immunity that lasts for one year only, after which it gradually disappears. Malaria and relapsing fever do not give any immunity at all and a further attack may follow soon after recovery. When dealing with diseases which have several serological varieties of the pathogen, as in poliomyelitis, dysentery and influenza, it has to be borne in mind that the immunity acquired is specific to the type of pathogen involved: it provides protection against repeated infection with the same serologic type of pathogen, but offers none against other serologic types of pathogen.

These features of susceptibility and immunity to infectious diseases determine the immuno-pattern of the population in relation to a particular disease, which reflects the epidemic processes occurring in a given community. The study

of the immuno-pattern is of importance for acquiring a knowledge of the laws governing development of the epidemic process in different localities and in different communities; it is important for the planning of prophylactic inoculations and for correct epidemiological prognosis. This department of epidemiology is frequently referred to as serological (immunological) epidemiology.

Immunological epidemiology offers sound explanations for variations in susceptibility to infectious diseases according to age. It is known, for instance, that infants under six months have a low susceptibility to measles. Subsequently susceptibility shows a sharp increase but by six or seven years of age it drops considerably, and the disease is rarely observed in children after 12. The explanation for this fluctuation is that babies under six months of age retain the immunity to measles acquired from their mothers, which is maintained by a supply of passive immunity in the form of antibodies contained in breast milk. This immunity disappears when breast feeding ceases and, having become completely susceptible to measles, children then contract this disease. In the older age groups the proportion of children who have suffered from measles increases gradually, so that the category of susceptibles shrinks and that of immune persons grows. In modern conditions the susceptible category disappears completely in the 7-12 age group, the process terminating earlier in urban communities than in the countryside where association among people is less intensive. In isolated localities the process may be delayed and susceptibles to measles might be found even among adults.

These laws of immunity according to age in regard to measles are also typical of other infectious diseases of children—scarlet fever, whooping cough, diphtheria, chicken pox, etc. It is obvious that these infections are peculiar to children not because of some specific features of a child's organism, but for the simple reason that people contract the diseases (or have an asymptomatic infection, as happens in scarlet fever or diphtheria) during childhood and the immunity acquired then lasts them all their lives. No doubt the physiological characteristics of childhood may also be of significance: it is a fact that irrespective of the

specific immunity, a child's organism is more susceptible to whooping cough, influenza and other infections than that of an adult. The comparison of measles and influenza, however, provides added proof that the grounds for distinguishing the group of so-called infections of childhood are more of an epidemiological than a physiological nature.

The epidemiology of measles and influenza is very similar. Children under six months of age have low susceptibility to both diseases, owing to the presence of maternal immunity. Both diseases are transmitted by the droplet method and the epidemic process in young children is, therefore, quite intensive. However, there is also a considerable difference between measles and influenza: post-measles immunity is stable and practically life-long, while immunity to influenza is unstable and is lost within one or two years of the attack. This is why measles is a disease of childhood while influenza afflicts any age group of the population.

Certain Characteristics of the Epidemic Process. The intensity of the epidemic process may vary, and therefore standard conceptions have been adopted in epidemiology to determine the intensity of the process.

Sporadic incidence is a term used to denote the morbidity level of a given disease which is ordinarily observed in a given locality within a surveyed period of time. A considerable excess above this level of incidence is called an epidemic, while the term pandemic is applied to an extraordinarily big epidemic, spreading over a considerable territory. The corresponding terms for the epizootic process are epizootic and panzootic.

A more accurate quantitative definition of the intensity of the epidemic process is difficult since everything depends upon the disease involved, the locality of the epidemic process and its duration. For instance, 1,000 cases of influenza in Moscow during winter should without doubt be regarded as sporadic incidence; however, if we were dealing with 1,000 cases of typhoid fever, they would be considered an epidemic and a considerably severe one. The same 1,000 cases of influenza occurring in a small town would be called an epidemic, and would also be considered an epidemic in Moscow if they occurred in the hot summer months.

Frequently in place of an epidemic we use the term epidemic outbreak or just an outbreak, when speaking of a small community or a group of people hit by mass morbidity. It is in this sense that the terms school outbreak, village outbreak, etc., are used even if the number of cases is only a few score.

Thus, the quantitative determination of an epidemic process in each case depends on the historical background and the epidemiological situation.

Another term frequently used in epidemiology is endemic disease, the antonym being an exotic disease. In the strict sense of the term endemic diseases are diseases peculiar to a given country or locality, while exotic diseases are imported diseases. From this point of view typhoid fever and measles are endemic to the U.S.S.R., while smallpox and cholera are exotic diseases.

In medical literature one sometimes comes across the term "endemic" used in contrast to "epidemic" and denoting a morbidity state in which an infectious disease prevails more or less continuously in a given region or is peculiar to it. However, in view of its inaccuracy and vagueness, the use of this term is ill-advised. There may be different reasons for the existence of endemic infectious diseases. In some cases they are associated with natural foci of infectious diseases, in others with people's living conditions, or they may be the result of both natural and social causes.

The theory of natural foci of infectious diseases was developed by Y. N. Pavlovsky. He has shown that many infectious diseases exist in nature independently of man, given a certain combination of natural conditions in a particular locality, the presence of warm-blooded animals and arthropoda vectors which are the reservoir of the pathogenic parasite. For instance, natural foci of tick-borne encephalitis are to be found in wooded (taiga) localities inhabited by chipmunks and other rodents, and by the *Ixodidae* ticks. The ticks become infected with the encephalitis virus while sucking the blood of diseased (infected) rodents and in their turn infect other animals when feeding on their blood. Furthermore, ticks can transmit the virus transovarially, thereby ensuring a continuous circulation of the virus of the

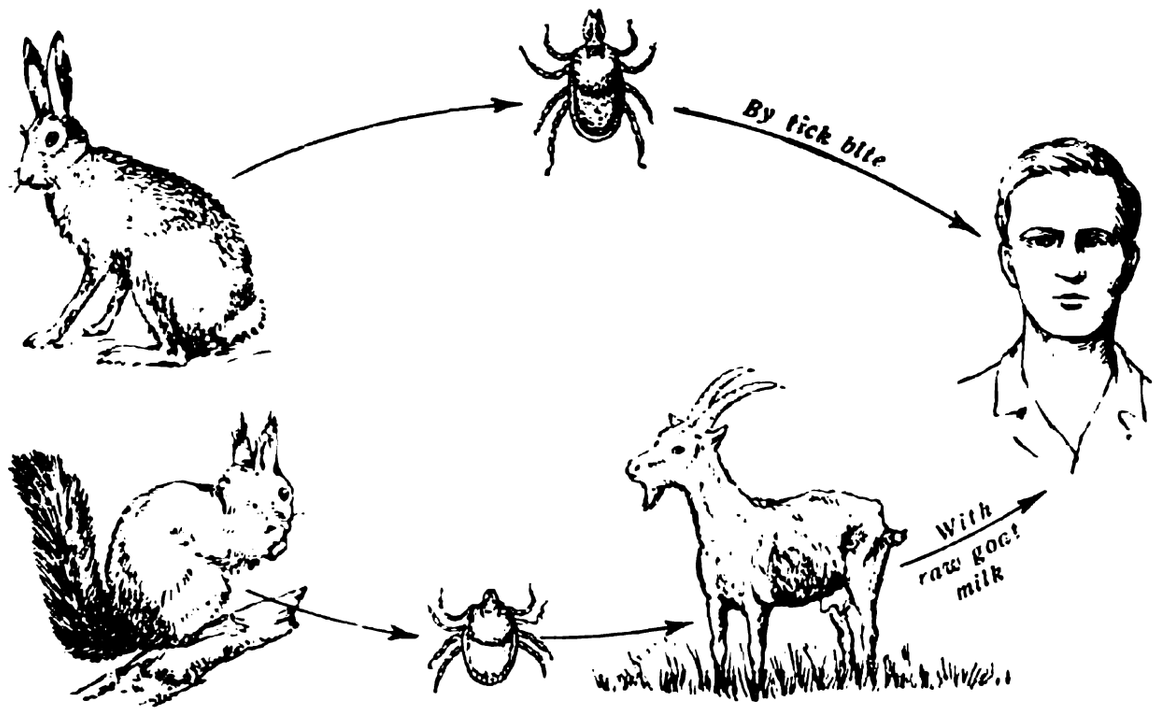


Fig. 16. A natural focus of tick-borne encephalitis

tick-borne encephalitis in certain localities—biotopes (the place of habitation) of rodents and ticks which have become the natural nidi of tick-borne encephalitis (Fig. 16).

Natural foci exist also for diseases which are not transmitted by anthropods. For instance, the anicteric leptospirosis is an infection of small mice-like rodents inhabiting marshy localities. The rodents contaminate the reservoirs with their urine and so transmit the leptospira to each other. Thus, swampy localities and floodlands serving as biotopes for the rodents have become natural nidi of anicteric leptospirosis and exist independently of man.

In addition to natural foci, the living conditions of the people also contribute to the presence of endemic diseases. Before the 1917 Revolution relapsing fever was endemic amongst poor people affected by lice, but the improved conditions following the Revolution, as well as the introduction of anti-epidemic measures, have led to the eradication of relapsing fever.

Malaria is an example of a combination of natural and social conditions being responsible for an endemic disease. The possible zone of the spread of malaria is confined to localities favourable for the development of the *Anopheles*

mosquito—a vector of malaria. In reality the spread of malaria depends on living conditions, and also on the effectiveness of malaria-control measures. This is why the construction of hydroengineering structures in the U.S.S.R. has not resulted in malaria becoming endemic in the flooded areas, whereas in the case of the Panama Canal construction a very severe epidemic of malaria broke out.

Another term current in epidemiology is "focus". According to L. V. Gromashevsky, the term focus should be applied to the site of an infection source together with adjoining territory within the range of possible contagion for those around; the period of its existence is confined to the maximum period of incubation following the destruction of the infectious agent in it. Hence, the focus is the elementary cell of the epidemic process. When smallpox is diagnosed, therefore, the sufferer is isolated in hospital for infectious diseases, his home is disinfected and all who have been in contact with the patient are vaccinated and remain under medical observation for 14 days, i.e., the maximum incubation period in smallpox. In the case of bubonic plague, the patient is placed in a specialised hospital, his home is disinfected, and all insects and rats destroyed; contacts are isolated for up to nine days.

The focus is not necessarily the home of the sick person but may also be any other place where he could have infected other people. For instance, if a child who is attending a crèche gets measles, it is not only his home that is regarded as a focus if it has other young children who have not suffered from measles, but also the crèche the child goes to. Thus, the correct determination of the boundaries of a focus is important not only for an understanding of the epidemic process, of which the focus is a part, but also for practical purposes—for the choice of measures to eradicate the focus itself.

In a broader sense in regard to a locality, region or a whole country where there are active sources of infection and factors of transmission of the infectious entity, we speak of natural foci of infectious diseases ("Vladivostok and adjacent territories is a focus of Japanese encephalitis") or of localities which are endemic for a given disease ("The world foci of cholera are found in India and Pakistan").

Conditions for Existence and the Motive Forces of the Epidemic Process. The epidemic process, which manifests itself in a sequence of three links (sources of infection, factors of transmission, susceptibles), should by its nature be classed with biological or, to be more exact, ecological phenomena because it is constantly influenced by natural factors. Moreover, the natural factors constitute the conditions in which the epidemic process is manifested.

This influence may be most clearly observed in the group of diseases transmitted by the blood-sucking arthropoda. The existence of natural foci of plague is governed by concrete natural conditions. The reservoir of the pathogen is found in numerous species of rodents: gebrils (shrew mice), marmots, susliks (gophers). The circulation of the pathogen is accomplished through fleas which are parasitic on these rodents. This biocenosis (fleas—rodents) exists only in certain geographical and natural conditions. Thus, not only the circulation of the pathogen in plague foci, but its very existence is determined by natural conditions. As distinct from plague, malaria only affects man. The area of spread of malarial mosquitoes is determined by climatic and geographical conditions, the mosquitoes being active during the warm season. If we bear in mind that the development of a plasmodium in the mosquito also requires particular conditions, it becomes clear that the area of spread of malaria is more limited than the area of spread of malarial mosquitoes.

Natural conditions also influence diseases transmitted without the mediation of blood-sucking vectors. The incidence of typhoid fever and dysentery is uneven, its peak coinciding with the summer months. There are serious grounds for believing that this phenomenon is due to the intensified activity of flies and other factors during the summer months.

Even in diseases transmitted by the droplet method, where the influence of natural factors would appear to be minimal, it has in fact been found to be considerable. It is known that the incidence of influenza increases in the cold seasons of the year (Fig. 17). The reasons for this seasonal pattern undoubtedly include the influence of natural factors: in conditions of increased humidity and low temperature, the influenza virus has more resistance in

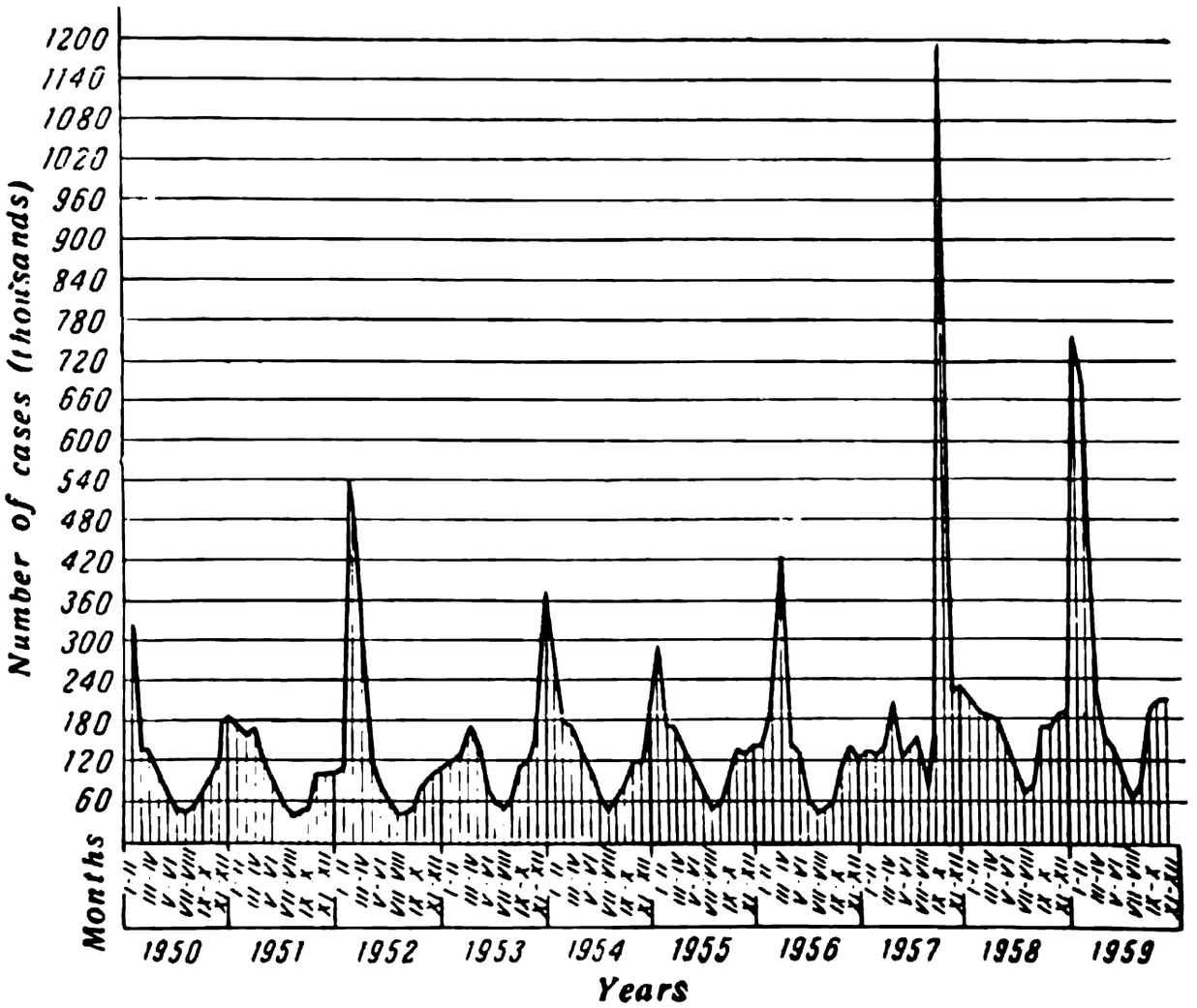


Fig. 17. Influenza morbidity in Moscow for 10 years

air, therefore the average infective dose in winter is higher than in summer. At the same time the resistance of the human organism to infection in winter diminishes owing to lack of vitamins, the influence of cold, etc. Thus, natural factors have an undoubted influence upon an epidemic process, and can act upon any of its three links. Nevertheless, natural factors are not the motive force of an epidemic process, but constitute the conditions in which this process manifests itself. The social and living conditions of the people (i.e., socio-economic factors) constitute the motive force of an epidemic process.

Differences Between Epidemic and Epizootic Processes. The differences between epidemic and epizootic processes are shown by comparing infectious diseases in man and animals. There is no doubt that they have a common biological background. Infectious diseases in both animals and man are

phenomena of a biological nature, since the infectious process is basically the relationship of a pathogenic parasite and the host organism (macroorganism); the main content of an epidemic or an epizootic process is the transition of the causative agent from an infected organism to a healthy one, or to be more exact—the spread of the pathogen among its hosts.

However, there are considerable differences between infectious diseases in man and in animals.

The infectious process in man's organism differs from that in the organism of an animal because man's central nervous system differs qualitatively from that of the animals. This qualitative difference, as was shown by I. P. Pavlov, the great Russian physiologist, is that man has a second signal system—the power of speech and thought, which is absent even in the most highly-organised animals. Since the nervous system regulates all the vital processes, the differences between the nervous systems of man and animals must influence the progress of infectious processes. This explains, incidentally, why the specific features of an infectious process in man cannot be reproduced in full in animals.

And yet the greatest difference between infectious diseases in man and in animals is not the differing reactions of their respective organisms to the invasion of pathogens, but the qualitative difference between the epidemic process and the epizootic process.

The epizootic process is the spreading of the causative agent among animals, and is conditioned by the life of the animals. The motive forces of an epizootic process are biological factors, since the life of animals is governed by biological laws.

The epidemic process is the spreading of the causative agent among people in human society, and therefore depends on the conditions of social life. The motive forces of the epidemic process are social factors, since the life of people is governed by social laws. The following example shows the essential difference between epidemic and epizootic processes.

Tick-borne encephalitis is a wild animal disease with natural foci. The hosts of tick-borne encephalitis virus are chipmunks, ticks and

some other species of small animals inhabiting the taiga. Ticks become infected when sucking the blood of diseased animals, and having acquired the infection transmit the virus to healthy animals in the course of blood-sucking. Furthermore, the infected ticks can transmit the virus via their eggs to future generations. Thus, a continual epizootic process takes place, as a result of which the virus of encephalitis is preserved, although chipmunks which have suffered from encephalitis develop an immunity causing the destruction of the virus in their organisms, while a proportion of the infected chipmunks and ticks die from various causes. Both hosts of the virus—the chipmunk and the tick—have become adapted to existence in the taiga, and it is not surprising that the foci of tick-borne encephalitis exist only in taiga areas and only in places where there are both chipmunks and ticks. Moreover, for foci of tick-borne encephalitis to exist the number of both hosts must be adequately large. For instance, if the chipmunks happen to be destroyed to a considerable extent by some beasts of prey or perish from lack of food (failure of the crop of cones of coniferous trees, on which they feed), the epizootic process would become less intensive or would discontinue altogether, leading to the death of the virus and the termination of its natural focus. The same thing can happen if there is a radical decrease in the number of ticks owing to extermination by birds, unfavourable weather conditions for the breeding and development of larvae, etc. Thus the intensity of the epizootic process and its very existence depend upon biological factors and the latter are the motive forces of the process.

The processes are quite different in the case of cholera, which is a disease affecting human beings only. A cholera patient discharges cholera vibrios (bacteria) with feces. The infectious period lasts throughout the course of the disease; subsequently, if the patient recovers, immunity sets in accompanied by the death of the vibrios in the organism; some people continue to discharge vibrios even after recovery (carriers), but not for more than two or three months. Some infected persons do not contract the disease, but can discharge cholera vibrios in excreta for several days or weeks. The cholera vibrio dies rapidly on desiccation and exposure to the sun's rays, but it can remain viable for several days in water; it may also be transmitted by flies, surviving for several hours on their legs and for several days in their intestines. A person can be infected with cholera in the course of ingesting food and water contaminated by vibrio-infested feces. The contamination of water occurs when the excreta of patients or carriers are introduced into the reservoirs with sewage or as a result of linen-washing, bathing, etc. Food can be contaminated by the hands but more often by flies.

The above-mentioned properties of the cholera vibrio, the course of the infectious process and the methods of transmission of cholera explain the specific features of cholera foci. Cholera is prevalent in countries with a hot and humid climate, in areas with a high density of population living in inadequate sanitary conditions. The oldest focus of cholera is India, where in the lower reaches of the Ganges and the Brahmaputra cholera foci have existed for several millenniums. A warm and humid climate and abundance of stagnant water reser-

voirs facilitate the preservation of cholera vibrios in the environment. This, however, is not the main reason for India being the world focus of cholera. Many other places in the world can be found with similar climatic conditions, Central Africa, or Brazil, for instance, and yet there is no cholera in those places. The conditions of life of the people are responsible for the prolonged existence of cholera in India.

Under these conditions people contract cholera at any time of the year by drinking polluted water or through other social factors while in summer the number of infections increases sharply owing to the contamination of food by flies which breed in myriads in rotting garbage. There has been no improvement in the terrible conditions of the working people for thousands of years. Moreover, following the seizure of India by the British, poverty and exploitation reached a new pitch and led to an increase in the incidence of cholera.

During the pre-capitalist period, cholera was confined to India since trade between countries was not very great. With the development and consolidation of international economic relations under capitalism cholera spread beyond the confines of India. During the 19th and 20th centuries there have been six pandemics, which affected practically all countries in the world. Cholera was imported to Europe, America and other continents, over the busiest trade routes. Cholera spread to big European cities like London, Paris, Hamburg, Petersburg, and settled there for a number of years, since the peoples' conditions of life were conducive to its spread. The working class and the other labouring folk lived in urban slums in great congestion and poverty. Sewage flowed freely to the rivers which provided supplies of drinking-water. In the summer, myriads of flies swarmed into dwellings and market-places. It is hardly surprising that under these conditions cholera epidemics involved tens of thousands of people. The spread of cholera epidemics has only recently been restricted by the introduction of special quarantine measures and the construction of water-supply systems with decontamination facilities. Nevertheless, in India and adjacent countries, cholera continues to take an annual toll of tens of thousands of lives. The existence and spread of cholera, as shown by the above examples, depend on living conditions, i.e., social factors, and these are the motive forces of the epidemic process. The eradication of cholera in India and in the other countries where it is prevalent can become a reality only when health-protection measures coupled with social reforms are launched on a grand scale.

A comparison of the conditions of existence of the natural foci of tick-borne encephalitis and of the cholera focus in India shows the basic difference between the epizootic and epidemic processes, namely, the different motive forces of these processes—the biological factors in the epizootic process and the social factors in the epidemic process. This comparison confirms the conclusion that the origin, evolu-

tion and eradication of infectious diseases in man is determined by the socio-economic conditions prevailing, while subsequently man's activities in remaking nature also had a considerable influence on the evolution of the infectious diseases of animals.

Evolution of the Infectious Diseases of Man. Existing infectious diseases of man are of varying origins. The following basic sources of infectious diseases can be indicated. Some of them afflicted the ape-like forefathers of man and after undergoing, with man, a long process of evolution, have survived to our times. Others originated through the development of pathogenic properties by harmless parasites of man. Those of the third group were acquired by man from domesticated animals or from animals which had become adapted to habitation in man's dwellings independently of man's will. The fourth group stem directly from diseases of wild animals. Finally, the fifth group of diseases is the result of the adaptation of free-living species to parasitic existence in man's organism.

The origin and evolution of the indicated groups of infectious diseases is best shown by concrete examples.

The first group of diseases is probably the smallest in number. This is easily explained. The evolution from ape to man involved such radical changes in the conditions of life of man and his forefathers that only a few parasites were capable of adapting themselves to the changing conditions and surviving as biological species. One of the diseases inherited by man from his forefathers is malaria. At present, there are four known malarial pathogens. They are all closely related biological species. Three of them—tertian, tropical and quartan malarial plasmodia—were discovered in the past century, the fourth, the so-called *Plasmodium ovale*, was discovered only recently. Tertian malaria is found practically everywhere, and the other forms mainly in hot and warm areas. Malaria is transmitted to man by the bite of a mosquito of the genus *Anopheles*, which is found mostly in uninhabited regions but in some cases close to human communities. Besides malaria infection in man there is a large number of similar diseases of mammals and birds in which plasmodia are also causative agents. The plasmodia closest to those which cause malaria in man, are pathogenic for monkeys.

All these facts prove that the progenitors of malaria pathogens for man were the malarial plasmodia of man's ape-like forefathers who lived in trees in tropical forests. The primitive people, who came down from the trees and settled on the ground, engaged in fishing and hunting. They populated the banks of rivers and gradually moved towards regions with a colder climate. The mosquitoes of the genus

Anopheles existed in these regions, too, provided there were reservoirs where their larvae could develop; therefore, the conditions were present for the perpetuation of malaria. When men adopted a settled mode of life this was even more favourable for the continuation of malaria, since some species of the mosquitoes *Anopheles* had become adapted to habitation in the proximity of man's dwellings, feeding on the blood of people and domestic animals. It was in that period, if not earlier, that several types of malaria plasmodium originated. One of them—the plasmodium of tertian malaria—followed man farthest north since it became best adapted to unfavourable climatic conditions. In one variety of the tertian malaria plasmodium, attacks of malaria due to the invasion of parasites in the blood set in after a long incubation period of from six to eight months. The adaptive character of this peculiarity is obvious; since the brief summer in the northern latitudes is followed by a long cold season during which the mosquitoes are inactive, then, had the incubation period been brief (a few weeks), the onset of attacks would have coincided with the cold season of the year when the development of parasites in the mosquitoes would have been impossible. The result of the long latent period is that malaria attacks in people who have acquired the infection in the summer, appear in the spring of the following year, at the time of mosquito eclosion. During the brief summer the mosquitoes infect other healthy people who fall ill the following spring, etc. This ensures continuity of the epidemic process.

Thus, the contemporary species and varieties of malaria plasmodia originated in differing climatic conditions at an early stage of human civilisation. The existence of different forms of malaria in ancient times is confirmed by a fairly accurate description of them in Hippocrates' works.

With the development of society, the spread of malaria, far from decreasing, increased considerably, particularly in the epoch of capitalism when malaria advanced to new areas opened up by man. Extremely vast foci of this disease came into being in different countries.

At present, malaria is one of the most widespread diseases; hundreds of millions of people throughout the world suffer from it. Malaria epidemics have broken out during many wars, for war facilitates the spread of this infection. During the construction of the Panama Canal, the malaria epidemic acquired a truly catastrophic size and together with yellow fever was responsible for the death of a large proportion of the workers engaged on the project. The capitalist mode of economy for a long time nullified the effectiveness of anti-epidemic measures taken in some countries, and only in recent times have malaria-control campaigns become more successful thanks to advances in medicine and the launching of international malaria-eradication programmes.

The measures taken in the Soviet Union checked the epidemic spread of malaria. Planned economy makes it possible to forecast and prevent the development of malaria foci when new areas are developed. A strong organisation with a wide network of anti-malaria centres was set up to combat this infection and an effective system

of prophylactic measures worked out for which the state allocates huge sums. The incidence of malaria was practically suppressed throughout the country, and by 1960 its complete eradication was achieved in the few ramaining foci. It is significant that the hydroengineering schemes undertaken, including the construction of irrigation systems, in no way led to a rise in malaria morbidity but, on the contrary, became a factor for its suppression and eradication.

The second group of diseases already referred to originated through the development of pathogenic properties by harmless parasites of man.

The example of dysentery illustrates how some benign (non-pathogenic) parasites become pathogens of infectious diseases. The pathogen of dysentery are a group of related bacteria, a few dozen varieties in all, which are parasites of man and are not found in domestic and wild animals. Man's intestine is the normal habitat of the biological species most closely related to them—*Escherichia coli* (non-pathogenic parasite), which is distinguished by its extensive variability. Some of its varieties are very close to the pathogens of dysentery. As has been mentioned, *Escherichia coli* belongs to the non-pathogenic or conditionally pathogenic bacteria, but some of its varieties are causative agents of diarrhea, particularly in children. Other data also point to the relationship between these bacteria and prompt the conclusion that the pathogens of dysentery originated from *Escherichia coli.*

How did they originate? Any parasite which inhabits a host organism, in this case the intestinal tract, meets the resistance of the protective forces of the host organism. Adaptation to parasitism may follow several avenues. If the parasite inhabits the lumen of the intestine and is nourished by it, it develops in the main the ability to withstand the action of gastric enzymes. These properties are clearly expressed in *Escherichia coli.* However, if the parasite penetrates the mucous membranes, then it is subjected to the action of a greater variety of protective reactions of the host organism. A parasite, however, like any living matter, can become adapted to various conditions, including the action of the protective reactions of the host organism. In the process of overcoming them it becomes a pathogenic parasite, living not in the intestinal cavity but in its tissues. The multiplication of the parasite in the tissues, however, brings into action the entire set of protective reactions of the host organism, as a result of which the host organism, generally, destroys the parasite or renders it harmless. In this way a definite interaction sets in between the pathogenic parasite and the host organism. The pathogenic properties enable the parasite to overcome the general, non-specific protective reactions of the host organism; as a result of its multiplication in the tissues the organism becomes diseased and this brings into action the protective reactions which this time are of a specific nature, being directed towards the destruction of the given parasite or rendering it harmless. This is why the developing immunity is specific and differs from the non-specific protective reactions acquired or inherited by the host in the course of its evolution.

There is no doubt that dysentery travelled this path. As different varieties of *Escherichia coli* developed into pathogenic tissular parasites,

the typical clinical symptoms of dysentery began to take shape. The existing forms of dysentery reflect, in a way, the evolutionary stages of the pathogen's development. The Grigoryev-Shiga dysentery bacilli differ markedly from *Escherichia coli*: they have lost many enzymes, extremely necessary to a parasite inhabiting the lumen of the intestine and absolutely useless to a tissular parasite. However, they have developed an ability to produce a strong toxin which is non-existent in *Bacillus coli*. The reaction of man's organism to the invasion and implantation of this microbe is expressed in the characteristic clinical manifestations of the disease with the development of immunity. The Flexner dysentery bacilli are much closer to *Escherichia coli*: they have only partially lost their enzymes and do not produce exotoxins. The clinical symptoms of the disease are comparatively weak and immunity is imperfect.

What conditions are responsible for the development of *Escherichia coli* into a dysenterial pathogen? These conditions could not have appeared before the establishment of slave society, when people passed over to a settled mode of life and formed big communities. A disease of the dysenterial type was impossible among the scattered nomadic tribes and hordes. No doubt, the pathogenic varieties of *Escherichia coli* could have caused the disease in some members of the tribe, but were not spread any further. The situation was entirely different in the big communities of ancient society. The contamination of water supplies with excrement, the congestion of the population in primitive living conditions, the contamination of food by flies—all this was responsible for the mass dissemination of the pathogen among people. And what is more, in these conditions it was the diarrhea-causing varieties of *Escherichia coli* that had the greatest chance of entrenching themselves and spreading, since the diseased contaminated the environment with feces more intensively than healthy people. Information about diseases which closely resembled modern dysentery is found in Hippocrates' works.

The conditions which led to the appearance of dysentery pathogens were intensified in the subsequent periods of society's development and dysentery became one of the most widespread diseases. Since congestion of the population and lack of adequate public amenities decisively influence the appearance and evolution of dysentery, it is quite natural that this disease is particularly widespread in towns, chiefly affecting the poor strata of the population who live in workers' districts, in urban slums. The dissemination of dysentery is considerably influenced by the "exchange" of dysenterial microbes and their varieties between countries, during wars, colonial conquests, etc. The development of new species and varieties of dysenterial bacteria is undoubtedly continuing at the present time, and certain pathogens of dysentery are of recent origin, as is amply evidenced by the discoveries of new varieties practically every year.

It would be incorrect to say that the conditions facilitating the spread of dysentery have been fully eradicated in the Soviet Union. It is apparent, however, that the continuous improvement in the welfare and housing of the people, the development of urban public amenities, the improvement in the general standards of hygiene and

sanitation—all these factors not only restrict the spread of dysentery but also assist the carrying out of prophylactic programmes. These objective conditions combined with persistent measures against the spread of dysentery have already brought about considerable success in the control of this disease. The most serious form of dysentery caused by the Grigoryev-Shiga bacteria has been wiped out in the U.S.S.R. There is no doubt that other forms of dysentery will also be eradicated, though it should be borne in mind that the eradication of dysentery and the extermination of its pathogens will require many years of strenuous effort.

The diseases of the third group were acquired by man from domesticated animals or from rodents inhabiting man's dwelling. Typhus fever is a characteristic representative of this group and there is no difficulty in tracing its origin.

The forerunner of the epidemic typhus fever is one of the tick-borne exanthematous fevers or rickettsioses (for instance, Marseilles [Mediterranean] tick-borne typhus fever) widespread in the Mediterranean Sea basin. Their natural foci still require study, but there are no grounds for believing that their foci differ from related rickettsioses of the Old and New Worlds: the hosts of the rickettsias are mice-like rodents and the *Ixodidae* (pasture) ticks, which also serve as vectors. Foci of this rickettsiosis existed long before the appearance of man.

As towns grew up even in ancient times, mice-like rodents deserted their natural habitats, at first temporarily and then permanently, for human dwellings. The parasites brought by rats and mice to man's dwellings included rickettsias which cause exanthematous typhus fever. Unlike these rodents, the *Ixodidae* ticks-vectors of rickettsias failed to adapt themselves to existence in man's dwellings. In the conditions obtaining, rickettsias either had to perish or to become adapted to new hosts. This role was assumed by fleas, which as distinct from ticks had found favourable conditions of existence in man's dwellings. Thus tick-borne rickettsiosis turned into flea-rat-borne rickettsiosis, which still exists in many towns in Europe, Asia, Africa and America.

Some fleas of rodents attack man with the result that cases of rat rickettsiosis often occur in towns. In the towns of ancient civilisations the evolution of rickettsias reached another stage: man and his blood-sucking parasites became involved in the life cycle of rodent rickettsias whose most permanent blood-sucking parasites of man are lice and, therefore, rickettsias became adapted to parasitism in the organism of lice. This phenomenon was of far-reaching importance, since, unlike fleas, the lice of man (*Pediculus humanus*) do not attack animals and the adaptation of rickettsias to transmission by lice meant the loss of their former hosts—mice and rats. In this manner developed rickettsiosis of man, typhus fever, no longer bound to specific territories and transmitted from man to man by lice (Fig. 18). There are grounds for believing that the development of typhus fever was completed in the first millennium B. C. and that one of the first big epidemics of this disease took place at the time of the Peloponnesian War.

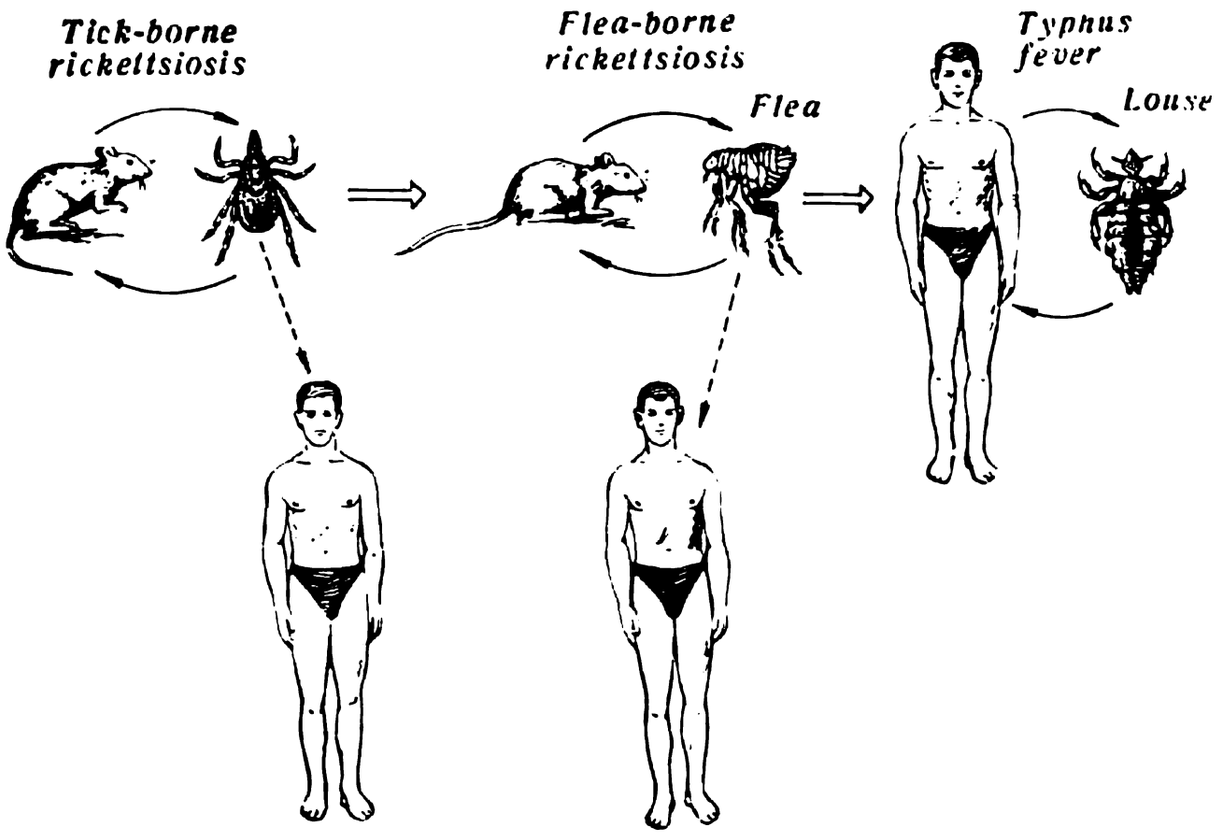


Fig. 18. Origin of typhus fever

Subsequently, typhus fever spread throughout the world. Wars, crusades, crop failures, famine, social upheavals and natural calamities were invariably accompanied by typhus fever epidemics up to the present century, when measures for combating the disease were worked out. This system is not fully carried out even in the developed capitalist countries, as shown by the epidemic of typhus fever which broke out among the Nazi troops at the time of World War Two. Typhus fever still occurs in capitalist countries, including the U.S.A., and is widespread in the colonies and the economically underdeveloped countries.

Typhus fever was a legacy of the tsarist regime, but ever since the suppression of the typhus epidemic of 1921-22, caused by the Civil War and the post-war crop failure, the incidence of typhus fever has steadily declined in Russia. The anti-epidemic measures adopted in the Soviet Army and in the rear during 1941-45 prevented typhus fever epidemics, and outbreaks in the areas under German occupation were eradicated shortly after liberation. Typhus fever as a mass disease was wiped out in the Soviet Union long ago as a result of improvements in welfare and standards of culture and the constant use of prophylactic measures. Sporadic cases occurring in some areas of the country demand the closest attention and investigation (see page 33).

The history of relapsing fever illustrates the origin and evolution of the fourth group of diseases, those acquired by man directly from wild animals.

The epidemiology of relapsing fever has many features in common with that of typhus fever. Both diseases afflict only man and are trans-

mitted by lice; epidemics break out in similar conditions, while the system of prophylactic measures is practically identical for both diseases. Relapsing fever, however, passed through a different course of evolution before it became a disease of man.

The forefather of epidemic relapsing fever was most probably tick-borne relapsing fever, whose pathogen—a spirochete—is very similar to the spirochete of louse-borne relapsing fever. The natural foci of tick spirochetosis may still be found in Central Asian deserts and semideserts. The hosts of spirochetes are small rodents (mainly the gebrils) and the *Ornithodorus* ticks, which also serve as vectors. Ticks infected by spirochetes transmit them to future generations. Similar foci of tick-borne spirochetosis exist in all continents; all of them are associated with rodents and the *Ornithodorus* ticks, while the spirochetes discovered in different countries are related species. The Central Asian tick-borne relapsing fever, however, has a significant distinction. Unlike other *Ornithodorus* ticks which are wild species, the vector of Central Asian relapsing fever—*Ornithodorus papillipes*—readily adapts itself to habitation in man's dwellings which are for the most part simple mud huts. This tick settles in cracks and chinks of the houses, attacks people and domestic animals and feeds on their blood. These peculiarities of the biology of ticks explain why in Central Asia, alongside the natural foci of tick-borne relapsing fever, its foci exist also in villages.

Apparently, these foci are the source of louse-borne relapsing fever which arose from the adaptation of tick-borne spirochetes to parasitism in lice. This process was made easier because the spirochetes remain in the blood of man infected by tick-borne relapsing fever for a long time, and also because spirochetes, as laboratory tests have proved, multiply in the organism of the lice.

It may be assumed that louse-borne relapsing fever arose at the peak period of the ancient civilisations of Central Asia and that the same kind of living conditions which led to the appearance of typhus fever in the area of the Mediterranean Sea, caused the appearance of relapsing fever in Central Asia. The further evolution of both diseases was in many respects similar. The adaptation to transmission by lice led to the spread of relapsing fever from certain territories to which it had been confined. The history of epidemics of relapsing fever, ever since man learned to diagnose this disease, has been much the same as that of typhus fever. It is not possible for us to go into detail, but we will only remark that relapsing fever is still found in colonial and dependent countries.

Since the epidemics of 1921-22 the incidence of relapsing fever in the Soviet Union steadily declined and in the post-war years the disease has been completely eliminated. Prevailing living conditions exclude the possibility of a widespread return of relapsing fever and have made its abolition all the easier. Louse-borne relapsing fever based on tick-borne fever is also unlikely to recur in Central Asia, as the conditions of the population in the Central Asian Republics today are basically different from those of the past, and the foci of tick-borne relapsing fever in the inhabited areas are being destroyed.

We shall now examine the fifth group of diseases, those which have developed as a result of the adaptation of free-living species to parasitism in man's organism. The forefathers of *Vibrio cholerae* are free-living vibrios—saprophytes of dirty reservoirs. Some of the saprophytes are so close to *Vibrio cholerae* that it is extremely difficult to distinguish between them. Cholera vibrios still bear signs of their water origin: they do not survive desiccation, they preserve well in water and even multiply in reservoirs containing organic remains.

The origination of cholera is the result of the adaptation of free-living water-borne vibrios to parasitism in human intestines and the development of pathogenic properties. The process is in many respects similar to the development of dysenterial microbes from *Bacillus coli*. India, which is still the world focus of cholera, must also be recognised as its place of origin. A combination of natural and social conditions which developed there in remote times resulted in the transformation of the water-borne vibrio into the pathogenic agent of cholera. The subsequent history of cholera has been outlined above.

We have discussed the main origins of various infectious diseases of man and their evolution. Let us now review in general the origin and evolution of infectious diseases of man at different stages in the development of human society.

The development of the organic world was accompanied by the emergence and development of varying forms of parasitism. Some parasites took up permanent habitation in the organism of their host, as a result of which many acquired pathogenic properties and became the pathogenic agents of infectious diseases. In different natural conditions natural foci of infectious diseases developed, the origination, existence and disappearance of which are governed by complex parasite-host relationships. The evolution of infectious diseases of animals is a result of a correlated evolution of pathogenic parasites and their hosts and is governed by general biological laws. Natural conditions, biological factors—these are the motive forces in the evolution of infectious diseases of animals.

With the appearance of man and the development of human society infectious diseases of man also appeared. Infectious diseases of man have the same biological basis as infectious diseases of animals: the relationship between the pathogenic parasite and the human organism is the essence of the infectious process, the dissemination of the pathogen among the population is the essence of the epidemic

process. The motive force of the epidemic process, however, are the conditions under which people live, the existing social factors, and, therefore, the evolution of infectious diseases of man is determined by the development of human society. Furthermore, with the development of the productive forces, man's intervention in nature has influenced the evolution of infectious diseases of animals.

The present infectious diseases of man emerged at different stages of man's history.

Only a few of them, such as malaria, enterobiosis, or herpes simplex, were acquired by man from his ape-like forefathers; the majority are of much later origin.

Even at the early stages of civilisation, in primitive society, man domesticated animals and rodents inhabited his dwellings. Domestic animals brought with them the diseases by which they were affected. New diseases developed as a result of an exchange of pathogenic parasites, and also arose in the natural foci; finally, the change in the conditions of life of domesticated animals compared to those of their wild ancestors led to the development of new infectious diseases. These processes which began at the time when animals were first domesticated continue to this day. Brucellosis, epidemic stomatitis (foot-and-mouth disease), glanders, rat-borne rickettsiosis, paratyphoid diseases, and many others do not affect wild animals; these diseases, regardless of man's wishes, result from his activities. Many of them afflict man, while some have served as the source of origin of diseases peculiar to man. The origin of scabies, several fungous diseases, streptococcal infections, a number of worm infestations and of viral urethritis probably dates back to the epoch of primitive society.

A considerable number of infectious diseases of man arose during the existence of slave societies. Typhus fever originated at that time, as well as relapsing fever, typhoid-paratyphoid diseases, dysentery, cholera, smallpox and a number of others. At a later date these diseases became widespread, the evolution of some of them resulting in the development of several pathogens (dysentery, typhoid-paratyphoid diseases, cholera).

The development of new diseases continued in medieval times. There are strong grounds for believing that such

diseases as measles, scarlet fever, influenza, syphilis and whooping cough originated or completed their development in that epoch.

In more recent times, in the epoch of capitalism, we have witnessed a wide spread of infectious diseases and their importation to various countries, some of them becoming pandemic. Intestinal infections became particularly persistent—as a direct result of the inadequacy of communal amenities in spontaneously growing big towns. Also widespread are droplet infections and tuberculosis, the dissemination of which is facilitated by congestion of the urban population and venereal diseases—occurring through the disruption of the family and the development of prostitution. There is no doubt that the process of development of new infectious diseases continues to take place.

The dissemination of infectious diseases is so clearly a result of the terrible conditions of the exploited masses in slave-owning, feudal and capitalist societies that they are called "social diseases". The development of productive forces and the progress of science in the 19th and 20th centuries has given people reliable means of combating infectious diseases. However, they cannot be used to the full under capitalism, just as it is impossible to introduce large-scale programmes for health protection under the capitalist system.

A minimum of anti-epidemic measures primarily for the protection of the ruling classes from such dangerous diseases as plague, cholera or leprosy, the spread of which might dislocate the entire life of a country, are carried out in capitalist countries. Protective measures against other mass infections are also undertaken owing to the pressure of the masses of working people in the course of their fight for better conditions of life. However, these measures in the main affect the metropolitan countries.

Socialist society is putting an end to epidemics of infectious diseases. The absence of exploitation, a planned economy, a steady improvement in national welfare and standards of culture, all this helps to restrict and eradicate infectious diseases. The changed conditions under socialism have had a striking effect on the incidence of venereal dis-

cases, which are being reduced with the liquidation of prostitution and the strengthening of family life; upon parasitic fevers which have become a thing of the past together with poverty and vagrancy; upon intestinal infections, the morbidity rate of which is dropping with the development of public welfare and the wiping out of slums so characteristic a feature of capitalism. The development of public health services and medicine in a socialist State is also of decisive importance for the successful control of infectious diseases. Prophylaxis and the elimination of infectious diseases are matters of paramount state importance and the Government allocates great funds and resources for these needs. Sanitary and anti-epidemic measures based on the latest medical achievements are carried out by all economic organisations and institutions, with very wide initiative displayed by the people under the guidance and supervision of public health bodies. It is this active prophylaxis and struggle against infectious diseases that constitutes the main guarantee for their reduction and elimination.

The great importance of prophylactic measures is confirmed by the way in which a number of infectious diseases have been eliminated in the Soviet Union and their occurrence prevented. It is a fact that the presence of malaria mosquitoes in many areas of our country is conducive to the dissemination of malaria and that the eradication of malaria in the U.S.S.R. is a direct consequence of the work done by the anti-malaria administration and its local centres. The disappearance of such a highly-infectious disease as smallpox, which was widespread in tsarist Russia, and the prevention of its introduction from adjacent capitalist countries, where it continues to cause epidemics, is undoubtedly due to the work of the sanitary anti-epidemic services. Irrigation development in deserts and semideserts is associated with man's penetration to natural nidi of infectious diseases and his exposure to infection; the absence of morbidity among the builders of hydroprojects and irrigation developments is testimony to the high standards of Soviet medicine and Soviet health-protection measures.

Many problems of prophylaxis, of the elimination and control of infectious diseases are still far from being solved.

Medical science, for instance, has worked out the principles of control of many helminthiases (worm infestations), but there is still an absence of reliable organisational methods for their eradication. Adequate means of control for such diseases as influenza, for instance, have still to be found.

There is no doubt that these problems will be solved. All the objective conditions for this now exist in the Soviet Union. As we advance from socialism to communism, our successes in the suppression of infectious diseases, in their prophylaxis and ultimate abolition will grow continually.

PROPHYLAXIS OF INFECTIOUS DISEASES

General Principles. Prophylaxis of infectious diseases is one of the main tasks of the Soviet health service. Prophylaxis comprises the following measures:

a) introduction of state measures for eliminating factors which give rise to infectious diseases;

b) introduction of specific medical measures against infectious diseases and for their prophylaxis;

c) health education of the population and encouragement of popular initiative to combat infectious diseases.

The first group of measures is covered by the economic plans which provide for the continual improvement of the living and working conditions of the population, the rise in its welfare and standards of culture. Many measures belonging to this group are of paramount importance in the prophylaxis of infectious diseases.

The development of industry in the U.S.S.R. is not haphazard but proceeds according to plan, and everything necessary for healthy working conditions is taken into account. Consequently, such occupational infectious diseases as anthrax at leather and wool-working enterprises, pneumoconiosis in the coal and ore mining industries, yeast mycoses at confectionary, sugar and canning enterprises, have been reduced or completely wiped out. The construction of canals, dams and hydropower plants in the post-war period, far from stimulating an increase in malaria morbidity in the river flood areas, helped to rid these places of malaria completely.

The development of socialist agriculture is also accompanied by radical measures which help to prevent and combat infectious diseases. There is no doubt that radical measures of control against zoonoses of domestic animals—brucellosis, anthrax, glanders, foot-and-mouth disease and Q-fever—only became possible with the establishment of collective and state farms. Such measures as milk pasteurisation, hygienic manufacture of *brynza* (sheep's milk cheese), mass vaccination of cattle against anthrax, foot-and-mouth disease and brucellosis, veterinary supervision at slaughter-houses and, finally, the establishment of hygienic conditions for people tending the cattle could only take place with big mechanised agricultural enterprises—the collective and state farms.

The planned nature of socialist economy makes it possible to carry out prophylactic measures when new areas are developed in zones of natural foci of infectious diseases. Striking examples of the effectiveness of these measures are the absence of cases of plague among people in vast territories which are natural foci of this disease, a sharp drop in tick-borne encephalitis during intensified development of areas which are the seat of its natural foci, and the reduction of tularemia morbidity to the minimum, though we have colossal territories where tularemia is an enzootic disease.

Housing and communal construction is one of the most effective measures in the battle against many infectious diseases, above all intestinal infections.

Adequate housing facilities coupled with sound town planning are of great importance in restricting the epidemic process of many diseases. Such diseases as tuberculosis, droplet infections of children and intestinal infections (dysentery, typhoid fever, infective hepatitis) are known to be associated with congestion and overcrowding. The large-scale housing construction now in progress, and especially the magnificent housing programme to be completed by 1965 will, therefore, ensure a reduction of morbidity in a big group of infectious diseases. Closely related to housing construction is the struggle against parasitic fevers, which in pre-revolutionary Russia were the diseases of the poor, huddled in slums and overcrowded barracks. As already

stated, relapsing fever and epidemic forms of typhus fever no longer exist in the U.S.S.R.

Special attention needs to be paid to children's institutions—nurseries, kindergartens, Young Pioneer camps, and also schools, boarding-schools and hostels for students and workers—where violations of sanitary rules may lead to the development of mass morbidity. Our experience has shown that given proper management these institutions are important agents in promoting good health. In the past the unhygienic conditions of laundries, hairdressing establishments and public baths were often the cause of the spread of various skin infections.

That is why these institutions are now built and operated in accordance with sanitary rules and regulations laid down by hygiene and epidemiology. Prophylaxis of skin and other diseases is also effected by such sanitary arrangements as showers and lockers for working clothes at industrial enterprises. Sanitary quarantine and disinfection posts which operate in transport, industry, construction, etc., help to control pediculosis.

The water-supply of a populated area is an important factor in the prophylaxis of intestinal infections. Drinking-water can be completely ruled out as a factor in the transmission of infectious diseases, provided the central water-supplies in towns, workers' settlements and rural communities come from a source which has been correctly chosen, protected by a sanitary zone, with proper purification and decontamination of the water ensured.

Water-borne outbreaks of typhoid fever and other intestinal infections traced down to water-mains can occur only where there have been gross breaches of regulations in the operation of the water-supply system; for instance, in the case of contamination of water sources with sewage, of a breakdown of pipes and resultant penetration of filth, of a linking up of the industrial water-supply system to the domestic supply. An adequate sanitary-epidemiological surveillance excludes such possibilities. In rural communities where there is no central water-supply system, good quality water can be supplied from artesian and other types of wells or from natural springs, provided these sources are protected against fecal contamination. The supply of drinking-

water in the U.S.S.R. is under constant supervision of sanitary bodies and is regarded as an important aspect in the prophylaxis of infectious diseases.

The sanitary aspect of reservoirs also includes the use of water for industrial and household needs, bathing, etc. Therefore, in the U.S.S.R. the sanitary protection of reservoirs is included in the water conservation measures, an important sphere of the national economy. During the fight against malaria the introduction of controlled irrigation and the breeding of gambusia as a means of destruction of mosquito larvae was of the utmost significance. The liquidation of dracunculosis (rishta) in some Central Asian towns was ensured by purifying the artificial reservoirs. Proper sanitary surveillance of the system of artificial irrigation is of great importance in the prophylaxis of amoebic dysentery.

The removal of filth and waste is an important measure in control of intestinal infections. The construction of a sewerage system in which sewage is decontaminated prevents fecal contamination of reservoirs. Sewage or garbage may serve as a hatching-site of fly larvae; therefore, the best results in combating flies—vectors of intestinal infections—are gained by the proper arrangement and selection of sites for dumps and places of manure storage, the correct construction and maintenance of cesspools. These measures also help to control geohelminthiases. Proper burying of carcasses of animals and the allocation of cattle burial-grounds prevent the dissemination of anthrax. Thus, all the measures involved in the removal of sewage and waste should be under constant surveillance of sanitary bodies.

Hygienic standards and regulations are strictly enforced in public catering, the food industry and the food trade in the U.S.S.R. Mass food-poisoning may result from faulty practices in cattle-slaughtering, violation of rules in the preparing and cooking of foods and in the storage of semi-cooked and cooked food. Faulty canning may cause botulism. Failure to observe sanitary regulations in the food trade can make food a factor of transmission of the infectious agent. Because the supply of food to the population in the U.S.S.R. is based on hygienic principles, many diseases transmitted by food have been either eradicated or reduced to

a minimum. An indication of the success in this field is the fact that cases of butulism are now rare, as the result of strict enforcement of hygienic standards and regulations in canning and fish-processing industries. Another example is the sharp decline in trichiniasis as the result of proper slaughtering and effective veterinary-sanitary inspection.

As can be seen from the above (far from complete) list of measures, they are not of a medical but an economic nature and extend to practically all aspects of our country's economic and cultural activities. At times these measures are referred to as general sanitary measures, which emphasises their role in health protection and the fact that they are under the supervision of sanitary bodies. The establishment of a special sanitary board, responsible for the elaboration of hygienic rules and regulations, for their observance by all industrial enterprises, institutions and organisations and for conducting sanitary inspection, is a practical implementation of the basic principle of the Soviet State in this field that it is necessary not only to fight infectious diseases but also to destroy their causes. This can be achieved only if prophylaxis is an integral part of the activities in all spheres of the national economy. In this respect, the public health bodies (the State Sanitary Inspectorate) enjoy facilities greater than those in any public health administration in a capitalist country.

Health education and the initiative of the people are important factors in the over-all system of prophylaxis and control of infectious diseases. Health-education work is the responsibility of every medical and health worker. The objective is to inform the population about infectious diseases and measures for controlling them, to promote hygienic habits and to teach the people simple anti-epidemic practices, a sort of first aid upon the onset of an epidemic disease (isolation of the patient before the arrival of a doctor, on-the-spot disinfection, etc.).

Health education should be conducted according to an established programme, and should also meet any immediate need arising from an epidemic. The elements of epidemiology as well as habits of hygiene should be taught from childhood, and provision for this should therefore be made in the work of mother and child consultation centres, nur-

series and kindergartens, the programmes of schools and teachers' training colleges. Apart from this, every health unit should work out a programme of health education in the light of local morbidity of infectious diseases, so that health-education work in a given area is directed against the diseases most prevalent there, and current prophylactic measures are followed up by health education. In this case, use must be made of all available means of publicity: radio, television, cinema, papers and wall newspapers, pamphlets, leaflets, posters, slogans, lectures and talks.

This work is stepped up during local epidemics, i.e., outbreaks of infectious diseases in a given area; in such cases it has to be supplemented by health-education work at the focal points. The health worker should advise the patients and their families on the measures they need to take and on what should be done to prevent the spread of the disease. This absolutely indispensable work is sometimes overlooked by doctors and nurses when calling on or receiving an infectious patient, with a resultant drop in the efficiency of anti-epidemic work.

The medical measures of prophylaxis and control of infectious diseases may be divided into prophylaxis proper and anti-epidemic measures. The former is conducted irrespective of whether there are any cases of infectious diseases at the time and aim at their prevention. The latter are taken when cases occur and aim at prevention or restriction of their further spread.

In the theory and practice of epidemiology definite prophylactic and anti-epidemic measures have been worked out with regard to most infectious diseases, which seek to break the continuity of the epidemic process. Some act upon the sources of infection by isolation of the patient. Etiotropic therapy (chemotherapy, antibiotics, sera) is also designed to neutralise the source of infection. The extermination of rodents—sources of plague, tularemia, leptospirosis, etc., is an essential parallel measure.

Measures of the other group seek to neutralise the factors involved in the transmission of the infectious agent. Most of the general sanitary measures described above have this objective. To this group of measures also belong disinfection of the focus, as a result of which the pathogen which

has emerged into the environment is destroyed, as well as the destruction of blood-sucking arthropoda or protection against their attacks.

Active and passive immunisation and chemoprophylaxis involve the susceptible population, the third link of the epidemic process. By means of active immunisation the organism of the inoculated person becomes fully or partially non-susceptible to the given disease. The same objective is reached by passive immunisation, but for a shorter period. Measures of chemoprophylaxis create in the organism a concentration of a preparation that acts bactericidally or bacteriostatically on the microbe which is expected to infect the organism.

Theoretically, it is sufficient to break any link in the epidemic chain to achieve a prophylactic effect. Sometimes this is the case. Thus in syphilis, the detection of patients and their subjection to a course of treatment (penicillin preparations of prolonged action) is quite sufficient for the liquidation of the disease, provided all patients are detected and adequate treatment is given. In this case the neutralisation of the source of infection is the basic or the sole measure of control. In the case of typhus fever the delousing of all persons in the foci is sufficient to rid a given area of the disease. In this case the desired result is achieved by acting upon the factor of transmission—the vector. In smallpox, the suppression of infection is achieved solely by total vaccination, which terminates the spread of the disease owing to the absence of susceptibles.

More often than not, however, all three links of the epidemic process have to be acted upon; first, because not one of the available measures is absolutely effective, secondly, because when one of the measures is effective in principle, there are still considerable difficulties in the way of its full implementation. The regular practice is to use a combined set of prophylactic and anti-epidemic measures to break the continuity of the epidemic process in each one of its three links. Thus, anti-malaria measures include detection and treatment of patients (action upon the source of infection), extermination of malaria mosquitoes in the larval and adult stages and protection against attack by them (action upon vectors), and also chemoprophylactic

measures for the population residing in areas subject to malaria (action upon susceptible organisms).

Typhoid-fever control includes isolation of patients in hospitals for infectious diseases, detection of carriers and their removal from work at food enterprises and waterworks (action upon source of infection), implementation of a set of general sanitary measures in the sphere of water-supply, sewage disposal, fly control (action upon factors involved in the transmission of the infectious agent) and prophylactic vaccination of certain population groups (increasing non-susceptibility). In tularemia, the measures of control include extermination of rodents (sources of infection), protection of grain and fodder from rodents, disinfection of water sources, etc. (factors of transmission), and prophylactic vaccination (immunity).

It is clear from these examples that a specific set of prophylactic and anti-epidemic measures has been developed for every infectious disease. Moreover, measures of medical and non-medical prophylaxis can be specific. In tularemia, for example, the extermination of mice-like rodents is as specific as prophylactic vaccination; similarly, the destruction of mosquito larvae is as specific a measure as the treatment of patients with bigumal (paludrine) and quinocide (anti-malarial aminoquinoline derivative). It should also be borne in mind that in any set of prophylactic or control measures for a given disease or a group of diseases the measures vary in importance; some are priority measures, some are subsidiary or secondary, depending on their effectiveness and the characteristics of the epidemiological situation. Disregard of these factors is liable to entail miscalculation in plans for anti-epidemic measures.

Epidemiological Survey. All cases of infectious diseases in the U.S.S.R. must be registered at a health institution by the medical worker who detects the disease, and the local sanitary-epidemiological station or the sanitary-epidemiological department of the district hospital must be notified immediately in most cases of infectious diseases by the medical worker concerned.

When a disease is detected, measures must be taken in the focus to prevent the spread of the disease, and this has to be preceded by an epidemiological survey.

The objectives of an epidemiological survey are: a) detection of the source of infection; b) determination of the focus limits; c) choice of measures of suppression. The epidemiological survey of a focus is similar to the examination of a patient by a doctor; its result should include the establishment of an epidemiological diagnosis and the carrying-out of measures to guarantee the suppression of the disease in the focus.

In diseases transmitted by humans, i.e., anthroponoses, the source of infection has a definite name and address, it is, in other words, a particular patient or carrier. The detection is imperative because an unidentified source of infection will continue to transmit the infection to other people. It is, therefore, not permissible merely to make a general statement such as "Infection was acquired from some new arrivals" or "Source of infection—contact in school." The identification of the source of infection, of a carrier specifically, is in many cases a difficult matter involving detailed questioning of the patient and the people around him, a survey of his home and place of work, microbiological examination and tests, etc.

In zoonoses, identification of the exact animal that has infected the patient is often impossible and impracticable. Nevertheless, in order that action may be taken against the sources of infection these have to be brought to light. Thus, where a case of brucellosis occurs the flock of sheep or herd of cows infected must be identified; when leptospiral jaundice occurs, it should lead to the detection of the rats which are the source of this infection; when there are cases of tularemia it is necessary to discover the places where the epizootic develops and the species of rodents involved in the epizootic process.

An important part of epidemiological survey is the ascertainment of the focal points of the disease, which are by no means always confined to the place where the patient lives. Quite often another focal point is his place of work, or, in case of children, the nursery school, kindergarten or school attended. Nor should the patient's visitors be overlooked. This is particularly important in cases of plague or cholera, when in order to localise the focus and to prevent the further dissemination of infection exact knowl-

edge of all who have been in contact with the patient is required. Insufficiently thorough investigation in these cases may lead to grave consequences. However, a whole school should not be declared a typhoid-fever zone because one case has occurred, and especially if there is insufficient evidence to prove that the school is the source of infection, and not the home (or some other place). In zoonoses, the ascertainment of the focal points is normally covered by establishing which farms are afflicted by the disease in question, if it is brucellosis, or by determining the area of spread of the epizootic, if we are dealing with a disease of the tularemia type.

As a rule the findings of an epidemiological survey are recorded in an epidemiological investigation card. These cards include a number of general questions and some which are specific in relation to definite groups of diseases. The cards are certainly of assistance in carrying out an epidemiological survey, provided we do not forget that they merely serve as guides and do not repeat the frequent error of confining the epidemiological survey merely to filling in the card. When an epidemiological survey is approached in this fashion it becomes a mere formality—the completion of a long questionnaire of little use and of no theoretical or field value.

Following an epidemiological survey, concrete measures should be worked out and prescribed for the suppression of the focus. The measures vary widely, depending upon the features of the disease and the nature of the focus. In most cases these measures involve the isolation of the patient, observation of contacts, disinfection, etc. The period for which the focus is placed under observation (the probable period of its existence) is ordinarily limited to the maximum incubation period of the disease, calculated from the date the patient is isolated or the animals, which are sources of infection, are destroyed or rendered harmless. It should be remembered that when drawing up measures for the abolition of the focus it is necessary to choose from among measures applied to the given infection those which will guarantee the best results in the specific conditions. It is practically impossible to lay down any standard formula; as in all other aspects of epidemiological surveys,

the decisions depend on the doctor's knowledge of the fundamentals of general epidemiology, the specific epidemiology of the particular disease and his ability to apply this knowledge in concrete conditions.

Apart from the survey of a single focus, the physician is confronted at times with group morbidity, outbreaks and epidemics. The principles and aims of the epidemiological survey in those cases are the same as in the case of a single focus.

Analysis of the morbidity rate is also important for the correct planning of prophylactic measures for the suppression of infectious diseases. This analysis may cover an area for which one doctor is responsible, a district, region or large administrative area, and various periods of time, a month, a year, or several years. An analysis of the effectiveness of the measures taken is most valuable for a proper appreciation of the results gained. Methods of epidemiological analysis and of the analysis of effectiveness of the prophylactic measures are set out in specialised manuals.

Anti-epidemic Measures in a Focus. Anti-epidemic measures in a focus may be divided into three groups: measures affecting the patient, measures affecting his contacts and measures involving the environment. Those involving the patient include detection, diagnosis and isolation; the latter is not obligatory in diseases which are not transmitted from man to man. Besides, as we have mentioned earlier, in many infectious diseases it is obligatory for the doctor immediately to notify the local sanitary-epidemiological station.

The detection of infectious patients may be active or passive. Passive detection is when the patients themselves request medical assistance. The higher the understanding of the community in relation to health protection, the more likely is its timely request for medical assistance. There are certain situations when active detection of patients becomes necessary by arranging house to house inspection. This method is used when there is a threatening epidemiological situation, when particularly dangerous infections appear or when there is the danger that they may occur. This method was successfully used in the war years and in the immediate post-war period to suppress a number

of infectious diseases and justified itself fully as an anti-epidemic emergency measure.

The doctor's diagnosis is based on clinical examination, laboratory analysis and epidemiological survey data. The comparative importance of these methods varies with the disease. In dealing with measles, for instance, complex laboratory tests are not needed in order to establish a correct diagnosis, whereas in case of diphtheria, laboratory confirmation of the diagnosis is indispensable. Correct diagnosis is often facilitated by epidemiological data. For instance, if the patient reports that he has been to the forest and has been bitten by ticks, this helps to diagnose tick-borne encephalitis. If the case history shows contact with an influenza patient, a diagnosis of acute catarrh of the respiratory tract will be excluded. Information about recent water-vole or hare hunting is often a good hint of tularemia, provided the patient has buboes, etc.

In many infectious diseases the diagnosis or suspicion of a certain disease entails compulsory hospitalisation. Plague patients must be placed in separate premises set aside for this purpose where the most stringent regulations are observed: medical personnel wear sterile overalls, protective masks, rubber gloves and high boots, and upon leaving the ward are subject to thorough disinfection. Smallpox and cholera patients are also subject to compulsory hospitalisation with strict isolation in cubicles. Extreme caution has to be exercised due to the acute danger of infection for those in close proximity to the patients and also for the medical personnel. In the majority of cases the patients are placed in the appropriate wards of hospitals for infectious diseases; to exclude hospital and ward cross-infection there are separate wards for specific infections, and patients are placed accordingly (typhoid-fever, dysentery, scarlet fever and other departments).

Particularly stringent rules of isolation should be enforced in departments for infectious diseases in children, which are transmitted by the droplet route. These departments should have a sufficient number of separate cubicles. The latter should also be available in diagnostic departments. Special regulations must be observed in the hospitals and wards for infectious diseases to offset hospital cross-

infection and contagion of medical personnel, and there must be constant disinfection of patients' excreta, utensils and other objects.

In some infectious diseases (chiefly zoonoses) hospitalisation of patients who are not dangerous as contacts is based on clinical indications. There are also numerous cases when hospitalisation is not altogether obligatory (dysentery, scarlet fever, measles, etc.), but is resorted to on clinical indications. Thus, patients suffering from dysentery or other acute intestinal infections are hospitalised either on clinical indications (when the disease takes a serious course necessitating qualified care) or on epidemiological indications—from children's institutions, flats with susceptible babies or in the case of substandard housing conditions. There are other cases when hospitalisation is not usually resorted to and the patient is isolated at his place of residence. This is done as a rule in the case of influenza, chicken-pox and German measles.

Hospitalisation and isolation terms depend on the length of the infectious period. In typhoid fever, dysentery, cholera, diphtheria and some other diseases, discharge from an infectious diseases hospital is subject to results of bacteriological analyses, namely, when two or three bacteriological tests have given negative results. In tuberculosis the patients are hospitalised while the tubercle bacilli are active. Once acute manifestations of tuberculosis have disappeared and the tubercle bacilli discharge ceases, the patient may be sent home with subsequent follow-up at a specialised clinic and outpatient treatment. Leprosy patients are placed in a leprosy hospital from which they may be discharged only if cured. This disease is now curable, provided specific treatment is started at an early stage.

The measures taken with respect to those in contact with the patient also vary with different infections. In the case of particularly dangerous infections—plague, smallpox, cholera—contacts are isolated in quarantine departments either in specially provided premises or in hospitals for the length of the incubation period and are kept under medical observation. In plague, observation is confined to medical examination and thermometry; in cholera, the persons under observation are examined bacteriologically to detect pos-

sible carriers. In smallpox, the contacts are isolated for seven days and are vaccinated without delay. The isolation period terminates after a week, but the suspects remain under medical observation for another 14 days. In many infections the method of segregation (quarantine) is used for contacts. These persons are not allowed to mix with large groups of people for the incubation period. For instance, if there is a case of measles in a family, other children in the family who have not been infected are kept away from children's institutions (nurseries, kindergartens, junior schools) for 21 days. Quarantine is practised intensively in infectious diseases of children and in poliomyelitis.

In addition to quarantine, the patients are sometimes subjected to prophylactic immunisation. Thus, in the case of measles they are given gamma globulin or adult serum, which creates passive immunity. Seroprophylaxis by gamma globulin is also used in infective hepatitis. Influenza contacts are given anti-influenza serum. There are some infectious diseases which do not call for any measures with regard to contacts.

In zoonoses, measures are taken with regard to persons who have been in contact with the patient, not because the patient is dangerous to them (with the exception of plague and glanders, the patient with zoonoses is not as a rule infectious), but because the circumstances instrumental in transmitting the infection to the patient may have acted upon the persons in contact with him (milk from brucellar cows, meat of anthracoid animals, bites from mosquitoes in the case of Japanese encephalitis, etc.). Consequently, those who have been in association with the patient should in most cases be placed under medical observation for the possible incubation period. In cases of anthrax, highly probable suspects are subjected to seroprophylaxis by anti-anthrax serum. In cases of plague, the same considerations may suggest chemoprophylaxis by streptomycin, a course of so-called preventive therapy.

In the case of infections with pathogens which survive after discharge into the environment, household objects which the patient has handled have to be disinfected. Bed linen and underwear are boiled, clothes, mattresses and

pillows and other objects are subjected to chamber disinfection and the premises to humid disinfection. In intestinal infections, the toilets are disinfected, and a drive is launched against flies. In parasitic fevers, clothes, underwear and bedding are subjected to chamber disinfection. In plague, rat-borne rickettsiosis and other diseases transmitted by house rodents, measures are taken to rid the building of rats and insects. Methods of disinfection and disinfestation will be discussed subsequently in greater detail.

As for quarantine measures to prevent infectious diseases being imported from other countries, these conform to the existing international agreements relating to plague, cholera, smallpox, yellow fever, typhus and relapsing fever. The present convention was adopted in 1952 by the World Health Organisation, of which the Soviet Union is a member. In pursuance of this convention the Ministry of Public Health of the U.S.S.R. in 1958 issued Sanitary Regulations on the Protection of the Frontiers of the U.S.S.R. Under these regulations, all ships arriving from foreign ports are classified as "clear", suspected or infected. Patients from "infected" ships are isolated and placed in special quarantine wards, contacts are placed under observation and according to the nature of the infectious disease are either detained or allowed to proceed after proper medical examination. Ships are disinfected and cleared of insects and rats whenever necessary. The regulations provide for the protection of frontiers against the importation of rats—frequent sources of plague in the past—and *Aedes aegypti* mosquitoes—vectors of yellow fever. The sanitary regulations enumerate in detail the measures to be taken to prevent the importation of each of the six infections covered by the convention.

There are separate sections concerning quarantine measures to prevent the importation of infection from other countries by land and air transport. Provision is made for the exchange of information among the parties to the convention on the appearance of the infections in question.

Besides all this, every country is free to establish its own rules aimed at preventing the importation of other infections not listed in the convention.

Prophylactic Vaccination. Prophylactic vaccination and active and passive immunisation play an important part in the system of measures to prevent and combat infectious diseases. The preparations used for active immunisation come under the general heading of vaccines, and preparations for passive immunisation are classified as sera. Bacteriophages are also used in the control of infectious diseases.

The following vaccines are used: a) live vaccines, b) killed vaccines, c) chemical vaccines, d) toxins and anatoxins. Vaccines consisting of one species of microbes are called monovaccines. A bacterial vaccine prepared from cultures of two or more strains of the same species is called a polyvalent vaccine. Bacterial vaccines made from killed cultures of more than one bacterial species are known as mixed vaccines. The term mixed vaccine is usually used to denote preparations comprising vaccines and anatoxins.

The most frequent aim of vaccination is prophylaxis, though at times it is used as a cure (vaccinotherapy in brucellosis and dysentery, for example). The antirabic vaccination is, essentially speaking, a method of cure, since it is given to patients infected with rabies during the incubation period and is designed to develop specific immunity before the virus reaches and affects the central nervous system.

Live vaccines are made from pathogenic microbes with attenuated pathogenic properties (virulence), obtained either by the selection of naturally occurring variants (smallpox, brucellosis) or artificially. Artificial selection is achieved in various ways: cultivation at unusual temperature (anthrax), on unfavourable culture media (tuberculosis), passage through animal organism (rabies, yellow fever), in chick embryo (influenza) or in tissue cultures (poliomyelitis, influenza), etc. Live vaccine immunisation is followed by immunity closely resembling natural immunity, since the administering of live vaccine entails the multiplication of the vaccinal microbe and a vaccinal process similar to the naturally occurring asymptomatic infection (though not identical, because of a qualitative difference between the vaccinal microbe and the natural one). The resulting immunity is close to natural convalescent immunity in length and potency.

Live vaccine immunisation is used as a protection against smallpox, tuberculosis, influenza, brucellosis, plague, tularemia, anthrax, skin leishmaniasis, yellow fever, poliomyelitis; certain preparations of the antirabic vaccine contain live virus. The possibility of live vaccine immunisation against typhus fever, measles, epidemic parotitis, psittacosis, dengue, mosquito fever has been proved experimentally and in a limited epidemiological practice.

There are various ways of administering the vaccines: epicutaneously (smallpox, tularemia, anthrax), intracutaneously (tuberculosis, plague), subcutaneously (brucellosis, plague, yellow fever), enterally (tuberculosis, poliomyelitis), intranasally (influenza). As a rule immunisation is a single operation and revaccination is carried out once every few years or when there are signs of an epidemic.

Vaccines made from killed microbes have also become widespread. The microbes are killed by lethal concentrations of formalin, phenol and other bactericides, or by heating to 56-60°C. Harmless vaccines may be obtained with the help of ultraviolet radiation and by ultrasonic techniques. Immunisation by killed vaccines reproduces humoral immunity, which is attested to by the appearance of the appropriate antibodies in the blood sera. Inasmuch as the immunisation given by killed vaccines reproduces the natural immunity only to a certain extent, double and triple vaccinations are used to increase potency; this has a cumulative effect on the antibody response. To the same end, microbial bodies are absorbed on slowly dissolving materials (ammonium alum, mineral oils), so that, as it were, a depot is established in the organism from which the antigens gradually find their way into the blood stream. These vaccines are called deposited or adsorbed vaccines.

Killed vaccines are used for immunisation against typhoid fever and paratyphoid fever (A, B), dysentery, cholera, leptospiroses, whooping cough, poliomyelitis, influenza, Q-fever, tick-borne encephalitis and Japanese encephalitis; most antirabic vaccine preparations contain killed virus. The possibility of using killed vaccines against certain forms of rickettsiosis, transmissive encephalitides, psittacosis and adenovirus infections has been proved experimentally.

Killed vaccines are injected subcutaneously (typhoid fever, cholera, whooping cough), intracutaneously (influenza), and intramuscularly (poliomyelitis). Enteral vaccines were used for dysentery, typhoid fever and cholera but were found to be of little effect.

Chemical vaccines are made from bacteria so treated as to extract antigens and remove ballast proteins. This is successfully done with the intestinal group of bacteria so that "complete antigens" are produced following the treatment of microbial bodies. When intestinal vaccines are used, larger amounts of the antigen can be introduced than in the case of the ordinary vaccine prepared from killed microorganisms, because the reactogenicity of the purified preparations is not intensified by ballast proteins. Deposited chemical mixed vaccine is used against typhoid fever, paratyphoids and dysentery; whenever necessary, cholera antigen and tetanus anatoxin are added. The advantage of this vaccine is that a single dose is sufficient.

In infections caused by exotoxin-producing bacteria, immunity is mostly of an antitoxic character and toxins may therefore be used for active immunisation. Toxins are ordinarily used in a harmless form produced by prolonged contact with weak formalin concentrations. This results in the formation of an anatoxin. Anatoxins are used in their native and purified forms—the latter in a deposited method. Anatoxin immunisation is used in diphtheria and tetanus; experimental data are available on the anatoxin action in the case of gas-gangrene and botulism. Anatoxins are frequent components of combined preparations (diphtheria-whooping cough vaccine, intestinal mixed vaccine with tetanus anatoxin, etc.)

Vaccine-induced immunity varies in length of effect. Smallpox-vaccine immunisation, for instance, lasts four or five years, immunisation against diphtheria and whooping cough two or four years, typhoid fever, one or two years, influenza, six or eight months. This means that in most infections revaccination is called for in order to consolidate and intensify immunisation. In diphtheria, the first vaccination is advisable in babies of five or six months, with three doses of diphtheria anatoxin (absorbed or mixed preparation); single dose revaccination should take place

in the second year, with subsequent revaccinations at the age of three, seven and twelve. As a rule, no further vaccination is necessary, since by that time life-long immunity is developed. It is only when there is a danger of an epidemic that children in the 15-16 age group have to be revaccinated. In influenza, to which immunity is weaker and more short-lived, annual vaccination is advisable for the most susceptible population groups.

Sera are prepared by hyperimmunisation of animals (usually horses) with microbial bodies, viruses or toxins and contain antibodies against respective infection in a high titre. In view of the fact that the antibodies are found in the globulin fraction of sera proteins, the latter are ordinarily purified and concentrated, with a resultant increase in the antibody titre and decrease in the allergic properties of the serum. Gamma globulin preparations are the purest. Besides animal sera, use is made of human serum and its purified preparation—gamma globulin—since the blood serum of adults usually contains antibodies against measles, influenza, infective hepatitis and other widespread diseases.

Sera are commonly used for therapeutic purposes, but in certain cases for prophylaxis; they are given to persons exposed to infection or in the incubation period. They are used prophylactically for tetanus, gas-gangrene, measles, influenza, anthrax, rabies and infective hepatitis. In most cases serum is administered intramuscularly, desensitisation and measures to prevent allergic shock being carried out according to rule. Certain sera are administered by inhalation (influenza) or externally on the wounded area (gas-gangrene, rabies).

Serum-induced passive immunity is ordinarily short-lived —two or three weeks. With the repeated administration of foreign serum to man (as a rule horse serum), the period of immunity is even shorter, since foreign protein is rapidly destroyed by the antibodies developed by the organism.

Strictly speaking, the bacteriophages cannot be called means either of immunoprophylaxis or therapy because they carry bacterial viruses which destroy the species of bacteria concerned. Bacteriophages have failed to justify the

initial hopes placed in them as a very efficient means of infection control. For instance, bacteriophages have been used on a limited scale in infectious diseases therapy. They are used somewhat more widely as a means of prophylaxis. In current medical practice dysentery, typhoid and cholera bacteriophages are used. Bacteriophages are administered orally and given to those who have been in contact with the patient. Observations show that the presence of bacteriophage in the intestines reduces morbidity, possibly as a result of diminished virulence of the infection. In the past, dysentery bacteriophage was a widely used prophylactic for younger children. However, with the appearance of phage-resistant forms of dysenterial microbe, this wide use of bacteriophage has been discontinued.

The importance of prophylactic vaccination differs with the disease. There are cases when vaccination is the basic, the cardinal and even the sole measure to ensure success in combating the infectious disease concerned. This is particularly true with regard to droplet infections with a long-lived post-infection immunity, for which effective prophylactic vaccines have been developed. These include smallpox, diphtheria, whooping cough and, to a considerable degree, tuberculosis. Vaccination remains the principal measure against poliomyelitis. Therefore, vaccination against smallpox, diphtheria, whooping cough, tuberculosis and poliomyelitis is given to all children and in certain cases to adults (when indicated for epidemiological reasons). It will not be an overstatement to say that the national morbidity rate of these infections (with the exception of tuberculosis) depends on the scope and quality of vaccination programmes, i.e., the efficiency of medical institutions and of the pediatricians and therapeutists who are responsible for vaccination in the areas they cover. It is advisable to administer anti-tetanus vaccines to children. Though this disease is infrequent, it is desirable for the entire population to acquire immunity against tetanus from childhood to offset even sporadic cases and avoid sensitisation of the organism on the introduction of horse serum.

The need for prophylactic vaccination against other infectious diseases is less universal and vaccination is administered either to exposed groups of the population or re-

stricted to definite areas where the diseases concerned are prevalent.

Anti-influenza vaccination is administered annually to those employed in transport, trade and the militia, since these groups have the greatest contact with the population and are particularly exposed during epidemics. The protection of these groups from influenza is specially important because mass morbidity among them disrupts public services in communities. For similar reasons anti-influenza vaccination is carried out at big industrial enterprises.

Vaccination against typhoid and paratyphoid fevers is carried out in areas where the morbidity rate of these infections is high, and first priority for vaccination must be given to population groups with higher morbidity rates or to persons whose ill-health endangers the health of many others (workers of water-supply system and food enterprises).

Vaccination against brucellosis, tularemia, plague, tick-borne encephalitis, leptospirosis, anthrax and Q-fever is carried out in areas where these infections occur. The most effective are vaccines against tularemia, brucellosis and tick-borne encephalitis. The administration of the appropriate vaccines has been instrumental in lowering the morbidity rate of these infections in several areas in the Soviet Union.

Yellow fever and cholera vaccines are only given to people leaving for countries where these diseases are widespread, while cholera vaccine is also given to people living in frontier areas when a cholera epidemic takes place in the adjacent country.

Vaccination is an important component of the prophylaxis of infectious diseases and it therefore has to be properly organised on a nation-wide scale, at republican, regional, town and district levels and in the area served by a polyclinic, hospital, or children's consultation centre.

For correct planning of prophylactic vaccination it is necessary to possess data on the number and age composition of the population residing in the area or district served by a polyclinic or hospital, and also on the differentiated morbidity rates in the given area. These data are used to compile annual plans for the prophylactic vaccination of

children and adults with due consideration for vaccinations performed in previous years, and to compile the lists of the vaccines and other materials needed: syringes, Jenner pens, cotton, spirit, ether, sterilisers, etc. When calculating the amount of vaccine needed, some 10 to 20 per cent has to be added to allow for possible spillage and to create a carry-over surplus lest there be a shortage during the vaccination campaign.

The schedule for vaccination in childhood is given in Table 2.

Table 2

Vaccination Schedule for Children

Age	Vaccinations
First week	BCG vaccine — three times: on the 2nd, 4th and 6th days after birth (perorally)
3 months	Smallpox vaccination
5-6 months	Vaccination against diphtheria, whooping cough and tetanus—three injections at monthly intervals
1 year 2 months-1 year 6 months	First revaccination against diphtheria, whooping cough and tetanus
2 years	Revaccination against tuberculosis
3-4 years	Revaccination against diphtheria, whooping cough, tetanus
4 years	Revaccination against smallpox
7 years	Revaccination against diphtheria and tetanus
8 years	Revaccination against smallpox
11-12 years	Revaccination against tuberculosis
12 years	Revaccination against diphtheria and tetanus and revaccination against smallpox
14-15 years	Revaccination against tuberculosis
17-18 years	Revaccination against tuberculosis
18 years	Revaccination against smallpox

The entire population from two months to 20 years of age is vaccinated against poliomyelitis; this can be combined with vaccination against other infections if the periods coincide with those under plan.

There should be an interval of two months between vaccination against different infections.

Vaccination against infections carried out only in definite areas or in definite population groups, when indicated for epidemiological reasons, has to be administered in the intervals between the current vaccinations, bearing in mind that the interval between two different vaccinations may not be less than two months.

Vaccinations are recorded by entries in special registers or preferably on individual cards. The vaccinations performed should also be recorded in every child's case history. An accurate record of vaccinations is particularly imperative, since incorrect data can nullify all the work done: the non-vaccinated will remain undetected, and those vaccinated may be given the vaccine for a second time unnecessarily.

Vaccination is performed by doctors or by junior medical staff under the supervision of a doctor. The methods laid down for vaccination have to be strictly complied with: a check must be made on the conditions of vaccine storage and on the quality of the vaccine, which should correspond to the specifications enclosed in the box with the vaccine, and asepsis is essential when administering the vaccine. This means not only sterilising the site of the puncture strictly in keeping with the regulations and ensuring that the ampule is opened aseptically, but also that the syringes and needles are completely sterilised. Both have to be rinsed and boiled each time they are used to prevent infection with serum hepatitis, whose virus might be present in the blood of asymptomatic carriers. Similarly, Jenner pens have to be boiled each time after use.

Since prophylactic vaccination is in the main performed by pediatricians and therapeutists responsible for a given area, and by the nurses who assist them, this group of medical workers must be quite familiar with the organisational and technical aspects of vaccination, so that vaccinations are administered in due time, with adequate vaccine and irreproachably performed.

Disinfection and Disinfestation. Disinfection is a term describing decontamination of the excreta of the patient and objects in the environment contaminated by him which can act as factors in the transmission of the infectious agent.

We distinguish between prophylactic, immediate, and final disinfection. Prophylactic disinfection is carried out to prevent the occurrence of infectious diseases, irrespective of their presence or absence at a given time. Immediate disinfection is carried out in a focus or at a medical institution where the patient is disseminating the infectious agent. Final disinfection is carried out following the removal of the patient from the focus, with the objective of destroying the pathogens still present in the environment.

The significance of different types of disinfection varies according to the infectious disease involved, i.e., according to the characteristics of the mechanism of transmission of the infectious agent and with the stability of the given pathogen in the environment. Thus, decontamination of the excreta of a typhoid-fever patient (immediate and final disinfection) is absolutely indispensable and is very effective in controlling the spread of this disease. At the same time, disinfection in measles after the removal of the patient from the focus (final disinfection) is absolutely useless, since the pathogen perishes quickly on objects and disperses in the air, while disinfection of the air in the patient's presence (current disinfection) is impossible. These examples show that in some cases disinfection is an important anti-epidemic measure, in others a secondary measure, and in still others is altogether unnecessary. Therefore the type and character of disinfection are specified for every type of infectious disease.

There are three methods of disinfection: mechanical, physical and chemical.

Mechanical disinfection to ensure the removal of the infectious agent include airing the premises, cleaning household objects with a damp cloth, removal of dust by shaking the objects or by vacuum cleaner, scrubbing of floors, walls, objects; the same ends are achieved by filtration of the air and by permanent ventilation.

Physical disinfection includes boiling, steam treatment, pasteurisation, burning, baking, and treatment with hot dry air, the use of ultra-high-frequency currents, ultraviolet radiation, X-rays and radium rays, ultrasound, sunlight, drying and low temperature.

The most frequent form of disinfection in the foci is the boiling of bed linen and underwear, crockery and other objects. Boiling should last (from the time boiling-point is reached) for 15 to 30 minutes to destroy vegetative microbes and one and a half or two hours to destroy microbial spores. In plague and anthrax foci, rags and objects of no particular value are burnt, metal objects are baked provided the process does not spoil them. The carcasses of small animals are burnt. Pasteurisation is used to decontaminate milk and also in the canning industry. In this process, milk or other food products are treated for 30 minutes at 56-60 °C three days in succession, which guarantees the destruction of vegetative microbes. Exposure to ultraviolet radiation is a widely used practice in microbiological laboratories in the manufacture of bacterial preparations and for the sterilisation of air in children's institutions, particularly in the presence of droplet infections. It should be borne in mind, however, that disinfection with ultraviolet radiation has to be carried out in the absence of the children, and this detracts from its effectiveness.

There is a long list of chemical compounds used as disinfectants. Their action is based on the bactericidal effect of chemically active groups. These compounds belong to haloids, chlorine-containing substances, phenol and cresol derivatives, salts of heavy metals, acids, alkali, spirits, aldehydes, etc. A comparatively small number of them, those distinguished for high potency, convenience and low cost, have become standard means of disinfection.

Chlorine, chloride of lime and chloramines act as oxidisers. Chlorine is used mainly to decontaminate water (chlorination). Chloride of lime should contain not less than 28-38 per cent of active chlorine, or 25 per cent at the least; it is used in dry form or in solution. Of great interest for disinfection purposes are chlorides of lime preparations with a greater content of active chlorine. Dry chloride of lime, when added to feces, phlegm and other liquid and semiliquid substrata in the proportion of 400 g per litre of mass, ensures reliable decontamination in two hours. For urine decontamination, it is sufficient to add to it dry chloride of lime in the proportion of 5 g per litre of urine; decontamination is achieved in ten minutes.

To prepare calcium chloride solutions, first its ten per cent solution is made (chlorine water). Chlorine water is used for whitewashing the walls, for decontamination of wooden objects (latrines, etc.). In the case of anthrax, the chlorine water concentration is increased to 40 per cent and the solution is used to whitewash all surfaces to be disinfected. Ordinarily, weaker solutions (0.5-1 per cent) of chloride of lime are used for disinfection. They are prepared from a settled ten per cent solution of chloride of lime by the appropriate dilution with water. As polished wooden, metal objects and fabrics, too, are spoiled by chlorine, it is not advisable to use chlorine-containing preparations for their disinfection. It is convenient to use more stable preparations—chloramine (27 per cent active chlorine). Table 3 is a guide to the proper use of these disinfectants (compiled by V. I. Vashkov).

Phenol is a good disinfectant ordinarily used in a three per cent solution. One of its advantages is that its bactericidal potency is practically unaffected by the presence of organic matter in the substratum. However, it is not sporicidal and its action against stable viruses of the poliomyelitis type is inadequate. Another shortcoming is its unpleasant smell. Phenol is used to disinfect excreta of patients and various objects and surfaces.

Cresol (impure carbolic acid) acts like phenol and is used for disinfecting toilets, stables, etc. Cresol treated with potash soap is called lysol, and is widely used for disinfection purposes. Table 4 is a guide to the proper use of this preparation (compiled by V. I. Vashkov).

Sublimate (mercuric chloride) $HgCl_2$ is a strong bactericide and in the ordinarily used concentration (1 : 1000) kills vegetative forms of microbes. However, its bactericidal properties drop sharply in the presence of organic substances and it is absolutely useless in the disinfection of feces, sputum, etc. It is used only for decontamination of floors, walls, furniture, leather and rubber goods, not polluted by excreta.

Hydrochloric acid in a one or two per cent concentration, with an addition of 8-16 per cent of sodium chloride, is used nowadays to disinfect hides and skins, since in such concentration it kills the spores of *Bacillus anthracis* in 6-120

Table 3

Application of Chloramine Preparations

Object of decontamination	Solution concentration, %%	Exposure	Notes
I. Linen and underwear without apparent traces of contamination:			
1) in intestinal infections	0.2	1 hr	
	1.0	40 min	
	3.0	10 "	
2) in scarlet fever and diphtheria	0.2	$1^1/_2$ hrs	
	1.0	60 min	
	3.0	20 "	
II. Linen and underwear contaminated with excreta:			
1) in intestinal infections	1	4 hrs	
	3	30 min	
2) in scarlet fever and diphtheria	1	5 hrs	
	3	50 min	
3) in tuberculosis	3	4 hrs	
	5	2 hrs	
III. Plates and dishes:			
1) with food remnants in intestinal and droplet infections	1	1 hr	
2) without food remnants	0.05	30 min	
3) without food remnants in tuberculosis	3	2 hrs	
IV. Disinfection of surfaces:			
1) in intestinal infections	0.2-0.5	30-60 min	depending on contamination
2) in droplet infections	0.5	1-2 hrs	
V. Excreta:			
1) urine (solution—1 part, urine—2 parts)	1	30 min	
2) feces (solution—2 parts, feces—1 part)	3	30 min	
3) Pus (solution—2 parts, pus—1 part)	3	2 hrs	
4) Sputum of tubercular patients (solution—2 parts, sputum—1 part)	5	4 hrs	

Table 4

Concentration of Lysol Solutions and Exposures in Disinfection

Group of infections	Treated object	Required concentration, %%	Required volume or ratio per unit (1 sq m, 1 litre)	Exposure	Notes
Intestinal	Surface (premises, furniture, etc.)	5	900 ml per 1 sq m	20 min	
Droplet	„	5	„	30 min	
Intestinal and droplet	Linen and underwear	3	„	60 min	
		5	1:4	15 min	
	Urine	2	20 ml per 1 l of urine	5 min	
Intestinal	Feces—loose, formed and with urine	3-5	1:2	30-60 min	Impracticable for formed feces

hours. In addition, a five per cent solution of hydrochloric acid is used for disinfection of urinals and to dissolve urine precipitates.

Formalin (40 per cent aqueous solution of formaldehyde CH_2O) is used as one or three per cent solution in the same cases as phenol, and also in vapour form to disinfect premises and for chamber disinfection. For decontamination of premises it is evaporated in special boilers at a rate of 12.5 ml of formalin per 1 cu m of premises. If there are many objects on the premises the concentration of formalin is increased two- or fourfold. Following an exposure of 10-24 hours the premises are aired and the remaining vapour is neutralised by sal-ammoniac: 500 g of sal-ammoniac in a mixture with 1 kg of slaked lime and 750 g of warm water is needed for 100 cu m of premises.

Disinfection in helminthiases differs from disinfection in diseases caused by microbial organisms.

In helminthiasis the eggs of worms contaminate soil and various household objects. Eggs of the most widespread helminths (*Ascaris*, *Oxyuris*, *Trichocephalus*) survive a brief action of disinfectants in standard concentrations.

This is why in helminthiasis no disinfection is done at the seat of infection. The best thing to do in the period of treatment (devastation) is to instruct the patient how to avoid scattering eggs of helminths by observing the rules of personal hygiene. Underwear must be changed before the beginning of treatment; dirty bedclothes and underwear have to be boiled; lavatory pans and chamber pots have to be decontaminated with boiling water. Filth removed from cesspools and sewers is cleared of eggs of helminths by biological methods—it is decontaminated at sewage farms or in compost pits. In the case of biohelminthiasis transmitted by foodstuffs (meat, fish), the latter are neutralised by ordinary culinary heat treatment.

The methods and means of disinfestation may be mechanical, physical, chemical and biological.

The common mechanical method is the cleaning of premises, the shaking and beating of soft objects, vacuum-cleaning and laundering. To protect the premises from flying insects the windows and doors are screened and bed curtains are used at night. The insects are destroyed by fly traps, fly-paper, etc.

The most common physical means of extermination are the use of blow lamps to clear places infested by bedbugs and other insects, hot ironing of clothes to destroy lice and the boiling of clothes to destroy lice and nits.

Chemical means of destroying insects may be divided into three groups: contact poisons which enter the organism of an insect through the cuticula; intestinal poisons which enter the organism of an insect with food; fumigants which enter the organism of an insect with air through the tracheal system. Certain insecticides can affect an insect by several of the above-mentioned mechanisms. It should be borne in mind that insects subjected to prolonged action of small doses of insecticides might become adapted to them and produce insecticide-resistant generations. This has been observed in flies and mosquitoes in areas treated with DDT and other insecticides.

Hexachlorocyclohexane ($C_6H_6Cl_6$) is at the same time a contact poison and a fumigant. It is used ordinarily as an hydrosaponite emulsion based on kerosene (200 g of the preparation +40 ml kerosene +60 g laundry soap are mixed

in a mortar and ten litres of water are added), or in dust form (6-12 per cent of hexachlorocyclohexane mixed with talc, tripoli or kaolin). It is used for external treatment (walls of houses, latrines, dustbins). The preparation has a persistent smell and is toxic; this is why it is not used inside dwellings.

The most commonly used insecticide is the preparation DDT; it is stable, highly toxic for insects, practically harmless for human beings and has no unpleasant smell. Ordinarily it is used as a two to five per cent solution based on kerosene or some other hydrocarbon, in dust form (five to ten per cent), and in paste forms. DDT is used for external and internal treatment of premises and for the impregnation of fabrics.

Prior to the development of DDT and hexachlorocyclohexane, pyrethrum, flicide, preparation K, preparation SK had been widely used; but now seldom. Thiophos and dieldrin are more promising. One of the older insecticides which is still in current use is "solvent" used as a saponite-solvent paste to kill bedbugs, lice and mosquitoes and as a saponite-solvent emulsion to soak linen and destroy lice on the hairy parts of the body.

Fumigation is usually done with chloropicrin or sulphurous anhydride.

Repellents are frequently used as protection against insects in wild natural surroundings. They are spread over exposed parts of the body or used to impregnate parts of clothing or netting worn on the head (the latter method was suggested by Y. N. Pavlovsky).

Solutions used for impregnation of clothing and nettings include: 1) lysol—15 parts, turpentine—8 parts, water—77 parts; 2) naphtho-lysol—20 parts, turpentine—10 parts, water—70 parts; 3) preparation K5—10 per cent solution; the same solutions may be used to impregnate bed curtains, gauze screens on windows, etc.

Exposed parts of the body are protected by dimethylphthalate in a pure form or a 15 per cent emulsion in glycerine or vaseline, or a 10 to 20 per cent alcohol solution. The preparation, its solution, or the emulsion is spread over the exposed parts of the body, care being taken to protect the eyes. After returning home, the preparation is

washed off the skin with water and soap. Pure dimethylphthalate or its solutions are also used to impregnate clothing and netting. The netting is made from ordinary fishing nets cut into 50 × 70 cm pieces (for head protection) or 60 × 25 cm (for hand protection); the edges are trimmed by a cloth band, and strings are sewn on to the corners. The netting is left in dimethylphthalate for two hours, then dried and worn over the headpiece or as oversleeves. As effective repellents for insects and ticks the nettings last for one to three weeks.

Biological methods of insect control include the breeding of gambusia and ducks which destroy mosquito larvae.

The destruction of rats is effected by mechanical, chemical and biological methods. Various factory or home-made traps are used to catch rodents. Additional prophylactic measures are the proper storage of food and waste (hermetic storage to prevent access by rodents), and the observance of technical requirements in the construction of dwellings, warehouses or other buildings in order to prevent rodents from intesting them.

Different poisons are used to destroy rodents; some act through the digestive tract when the rodents ingest poisoned bait, others kill the rodents by suffocation.

The following poisons are in current use: barium carbonate, raticide, ($C_{11}H_{10}N_8S$) zoocoumarin, sea onion, arsenous anhydride, zinc phosphide, barium fluorine acetate, phosphorus, etc. To destroy rats the baits should contain the following concentrations of poisons: raticide—one per cent, zinc phosphide—five per cent, barium carbonate—ten per cent, barium fluorine acetate—0.5 per cent, thallic sulphate—two per cent; to exterminate mice the following concentrations are necessary: raticide—0.5 per cent, zinc phosphide—two per cent, barium carbonate—seven per cent. The bait may be in the form of bread crumbs, dough, porridge, minced fish or meat, boiled vegetables, with a 0.25 per cent addition of sunflower-seed oil. Treated cereals can also be used. The bait is left in places frequented by rodents in the proportion of 0.1 of bait per sq m of treated area. Poisons may also be pulverised into the holes (raticide, zinc phosphide, calcium arsenite); in this case rats are poisoned after licking their paws and fur. Care must be observed when handling poisons since poisoning might

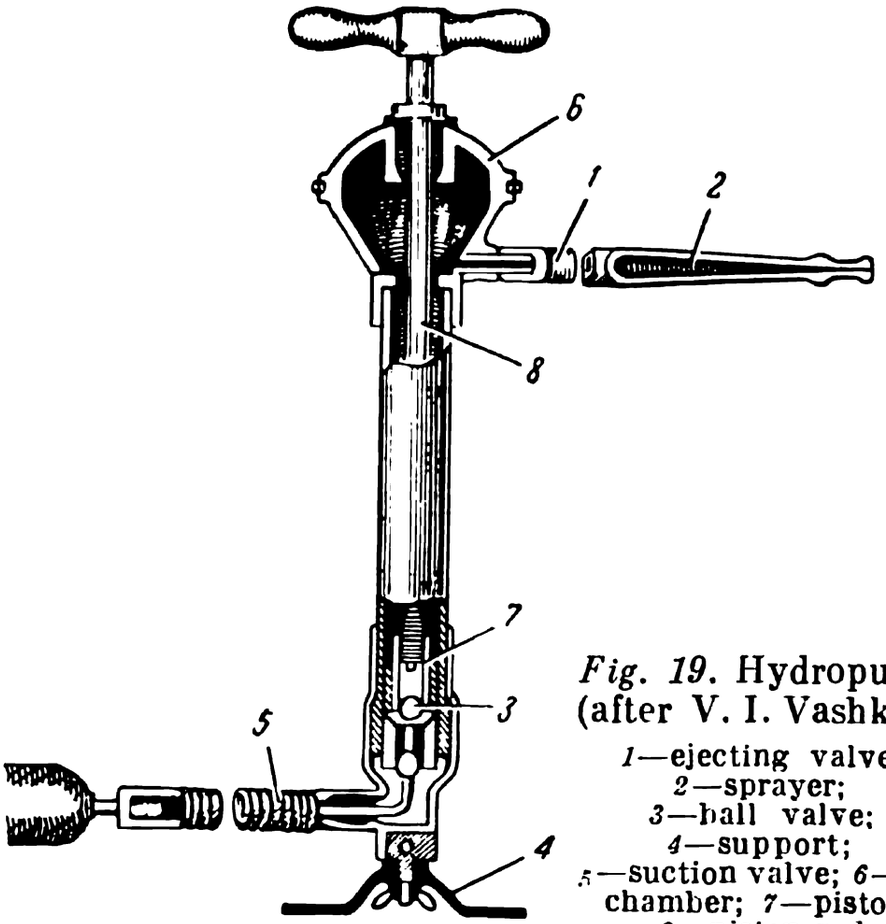


Fig. 19. Hydropump (after V. I. Vashkov)

1—ejecting valve; *2*—sprayer; *3*—ball valve; *4*—support; *5*—suction valve; *6*—air chamber; *7*—piston; *8*—piston rod

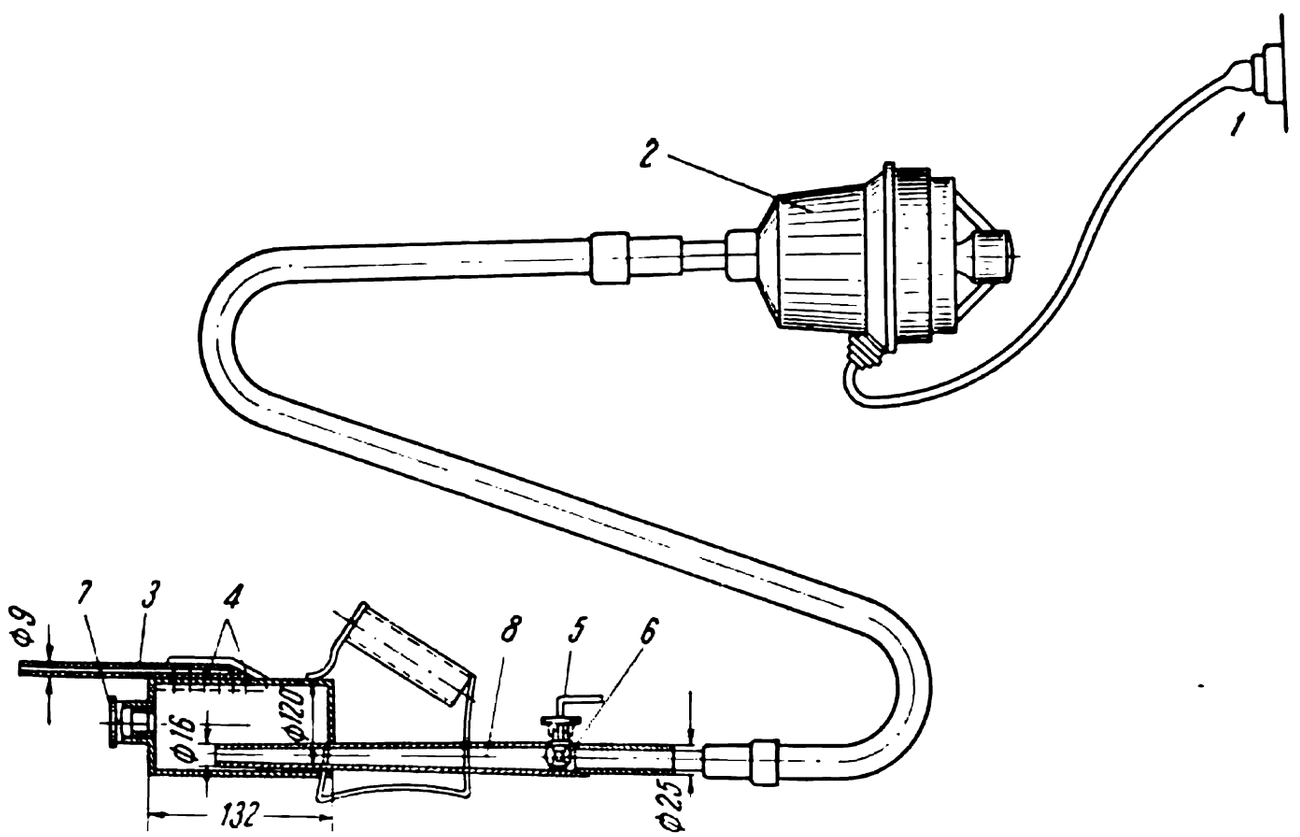


Fig. 20. Diagram of a mechanised blower-sprayer (after V. I. Vashkov)

1—electric socket; *2*—motor with fan; *3*—spraying pipe; *4*—perforations; *5*—handle; *6*—valve; *7*—stopper; *8*—pressure pipe

occur either during the preparation of bait, or by accidental ingestion of poison with food.

The gas method of extermination of rodents involves the use of sulphurous anhydride as well as chloropicrin, hydrocyanic acid, etc. Preparations of hydrocyanic acid absorbed on cardboard discs (discoid-cyclon) are the most effective and convenient. The discs are spread on the floor of the treated premises at a rate of one disc per 1 cu m of the area, which corresponds to 7.5 g of liquid hydrocyanic acid. The handling of gaseous poisons is a dangerous process and only trained people should be allowed to do it.

A biological method of rodent control is the use of a salmonellae culture pathogenic for rodents (the Isachenko-Danich and Merezhkovsky cultures), which is used as bait contaminant.

The resultant epizootic causes mass destruction of rodents. This method, however, does not bring about total destruction of the rodents and is not absolutely safe. Therefore, it is forbidden in the food industry, food storehouses, at children's and medical institutions, and at farms which breed young animals.

Various apparatus are used for disinfection. The simplest apparatus for the spraying of disinfectant solutions is a hydropump (Fig. 19). Besides the ordinary hand-operated pump, different types of electric pumps, automaxes and sprayers are used. They all consist of a container filled with the liquid disinfectant, a piston pump operated by hand or engine, and a spraying device. Large-capacity installations mounted on motor vehicles are used to disinfect big areas.

Powdered insecticides are spread by hand-operated sprayers of various types or by motor sprayers of varying power (Fig. 20). There are also combined apparatus for spraying liquid and powdered substances (Fig. 21). Aerosol tanks (so-called "aerosol bombs") (Fig. 22) and aerosol pots (Fig. 23) which give a fine mist of insecticide, are also used for the dispersal of insecticides.

A special apparatus is used for the evaporation of formalin. It consists of a tank filled with formalin and a burner (Fig. 24). To burn sulphur for killing rats an apparatus designed by F. G. Guzikov and M. A. Zausailov is used (Fig. 25).

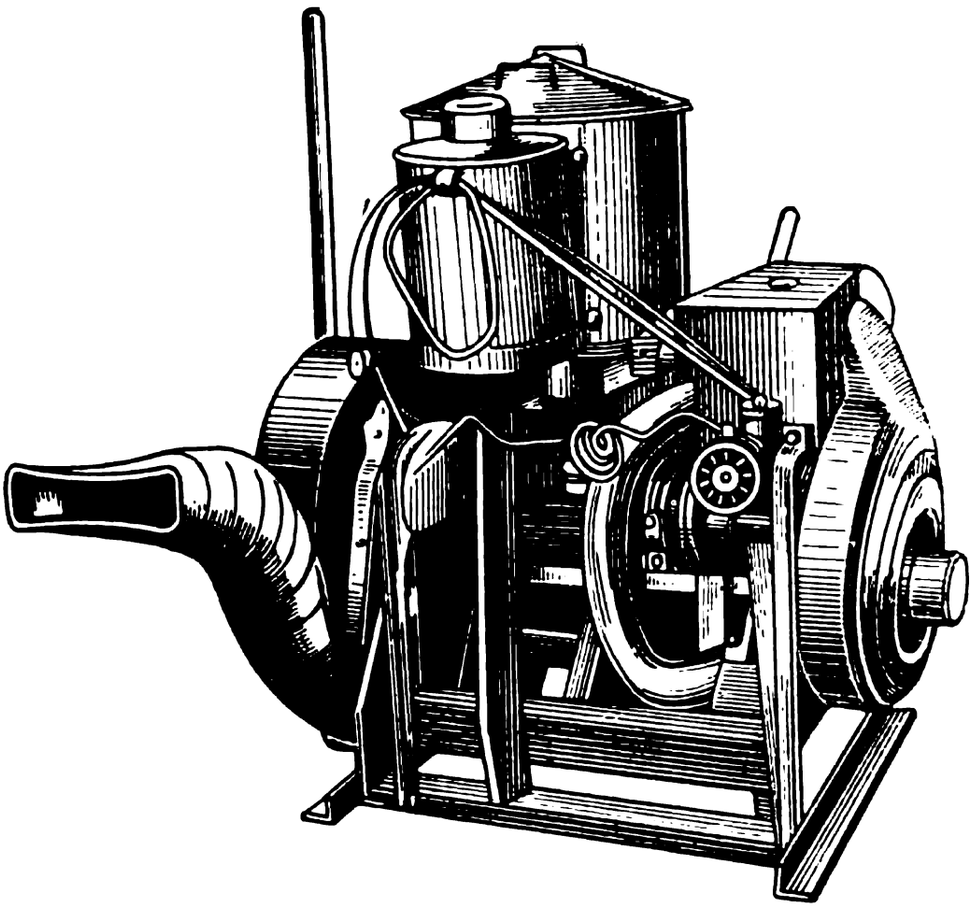


Fig. 21. Dusting machine of P. G. Sergiyev and V.A. Nabokov "Serna-2" model (after V.I. Vashkov)

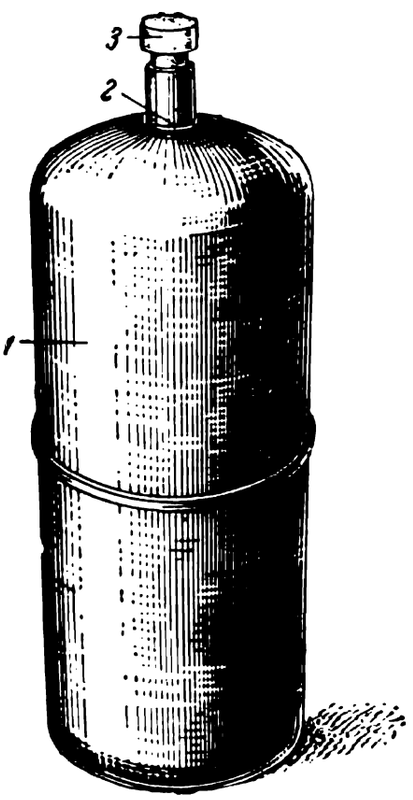


Fig. 22. Aerosol tank (general view) (after V. I. Vashkov)
1—tank case, *2*—connecting sleeve, *3*—metal stopper

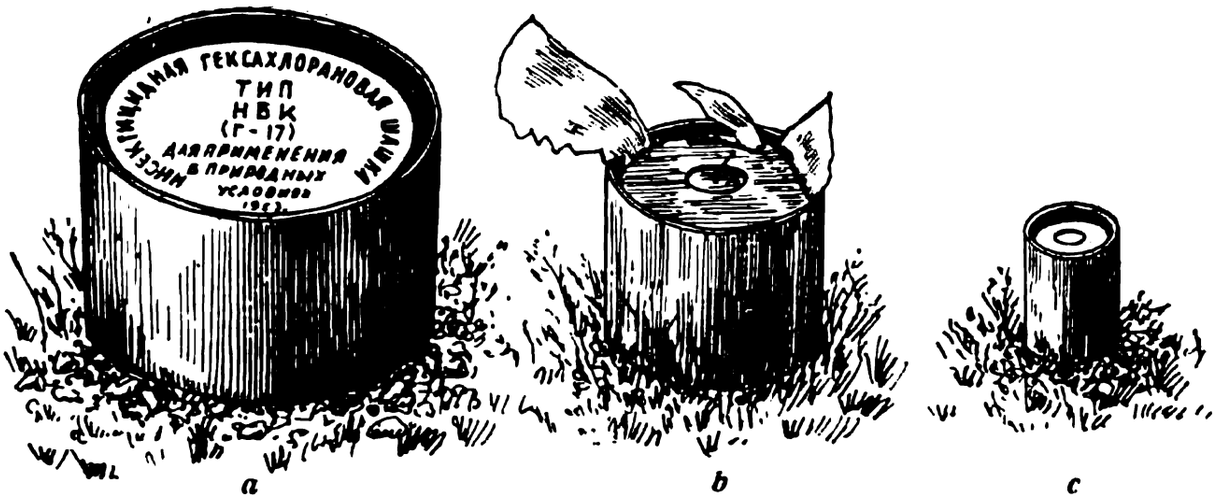


Fig. 23. Insecticidal hexachlorocyclohexane bombs of the "НБК" type

a—unopened bomb; *b*—bomb prepared for fumigation; *c*—trial bomb to show the direction of the air current

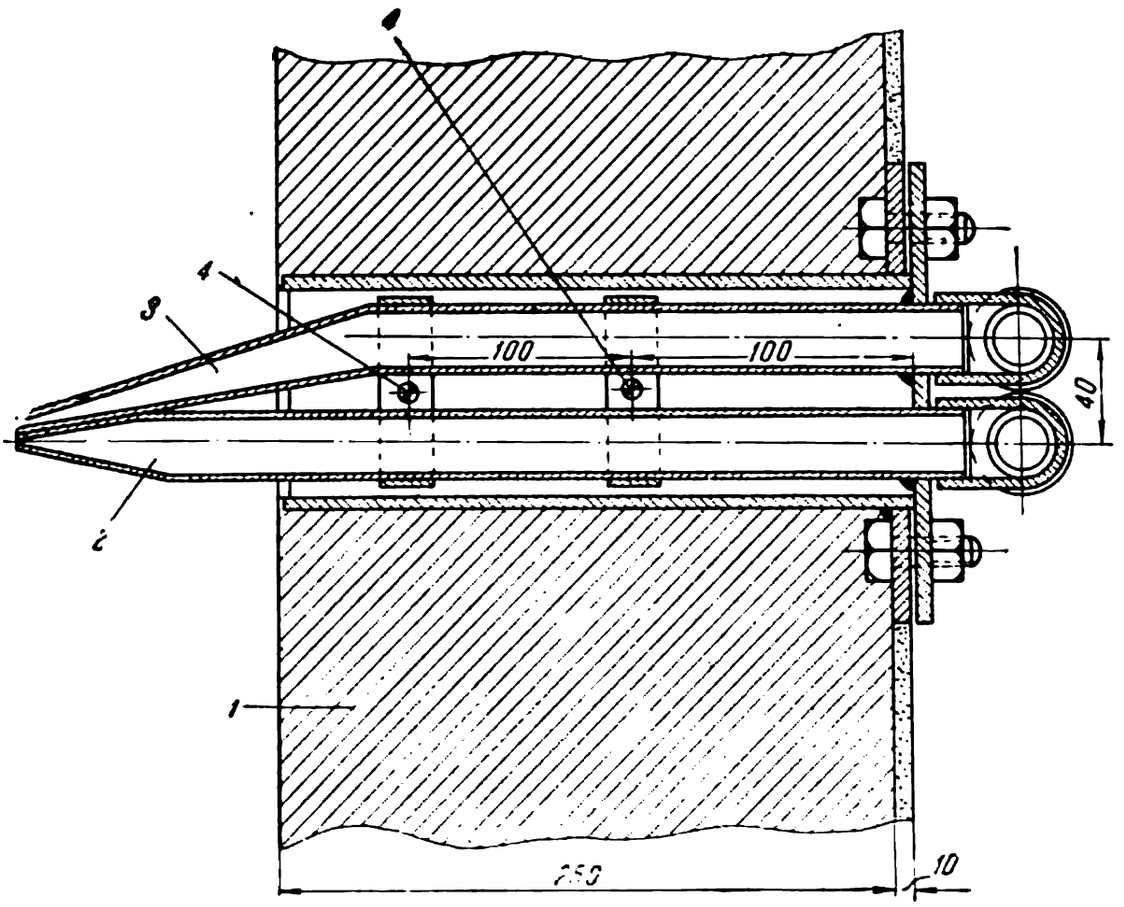


Fig. 24. Diagram of a simplified burner to spray formalin (after V. I. Vashkov)

1—wall of the chamber; *2*—steam pipe; *3*—formalin pipe; *4*—clamps

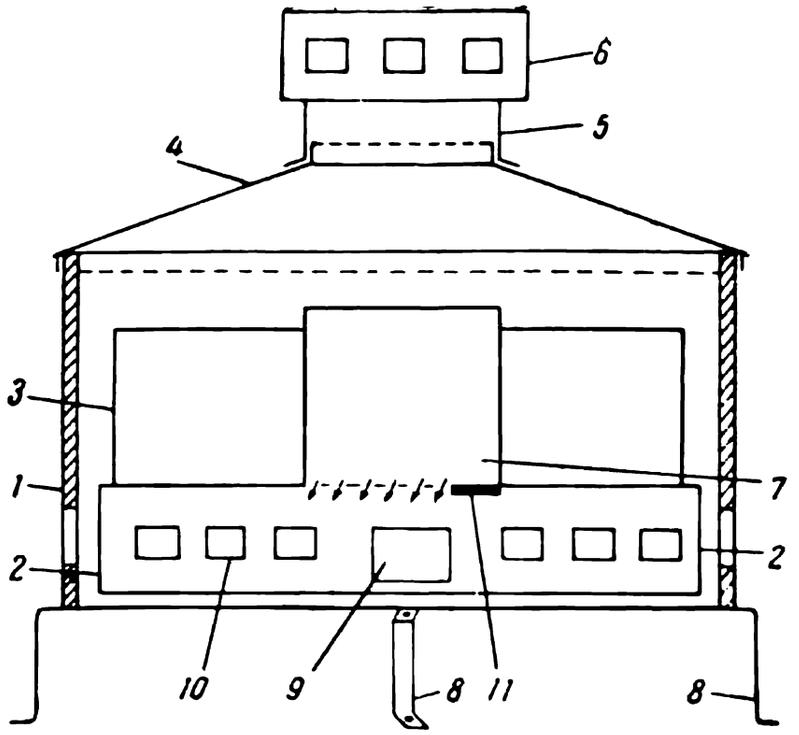


Fig. 25. Diagram of F. G. Guzikov's apparatus for sulphur burning (after V. I. Vashkov)

1—support basin; *2*—lower sulphur receptacle; *3*—upper sulphur receptacle; *4*—lid; *5*—exhaust funnel; *6*—wind vane; *7*—central department for sulphur with perforated bottom; *8*—folding leg; *9*—glass for alcohol; *10*—air slots; *11*—the weight of the automatic platform

Chamber disinfection and the destruction of insects is carried out by various types of disinfection chambers.

Dry heat chambers are based on the propulsion of dry hot air, which ensures the destruction of insects. The chamber may be stationary or transportable, stationary chambers can be easily built wherever necessary (dug-out chambers). Today this type of chamber is seldom used. A commercially produced and easily assembled sectional disinfestation chamber C-1 (Fig. 26) is in current use; dug-out chamber was used for insect destruction (lice), particularly in war conditions.

Steam renders, stationary and transportable, are based on the displacement of air by saturated steam, which has a sterilising and insecticidal effect. A disinfection cycle lasts 15-20 minutes at a temperature of 120°C (the equivalent of 2 atm). Among the drawbacks of this type of chamber is its impracticability for decontaminating leather and fur. At present two models of this type of chambers are being

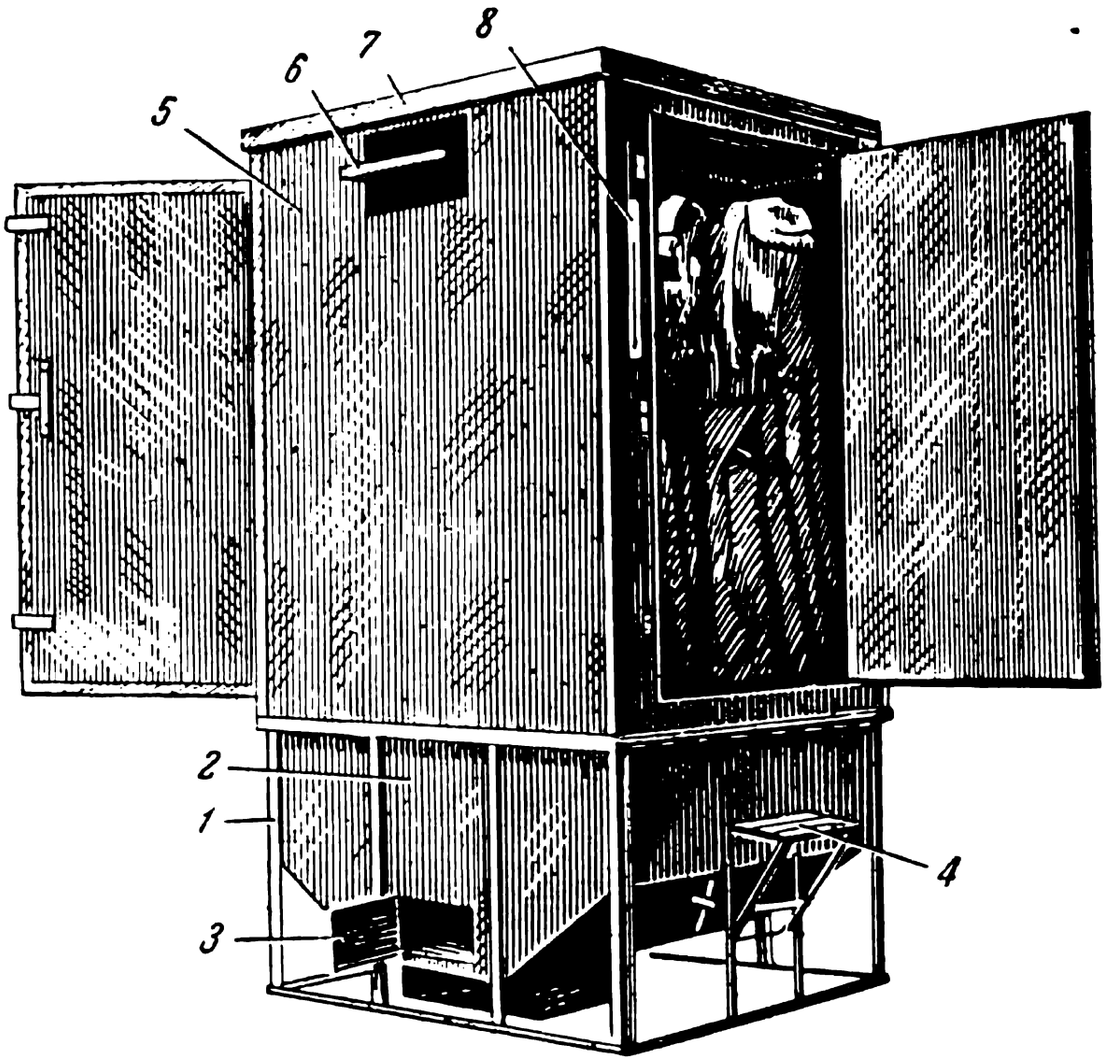


Fig. 26. General view of the hot air disinfestation chamber C-1 (after V. I. Vashkov)

1—frame angle; *2*—metal housing of the socle part; *3*—furnace door; *4*—folding step; *5*—side shield; *6*—gate slide of exhaust ventilation; *7*—upper shield; *8*—thermometer

manufactured, the Krupin stationary chamber and the Saks transportable chamber (Fig. 27).

The most efficient type is the formalin-vapour chamber which can be used for the decontamination of all types of objects. The formalin-vapour chamber consists of the chamber proper in which the objects to be disinfected are placed, coil pipes to heat the chamber and prevent steam condensation, the vapouriser and the sprayer. To begin with, the charged chamber is heated to a temperature of 40-45 °C, then steam is blown in, which evenly heats all the objects to a temperature of 60-65 °C (this is ensured by means of a fan) and after that pulverised formalin is charged at a rate of 25-100 g per 1 cu m of atmosphere. When the full

dose of formalin is blown in, the objects remain in the chamber for 20-40 minutes, after which the chamber is emptied and aired. At present, formalin-vapour chambers mounted on vehicles (Fig. 28) or on trailers are used; they can also operate as steam chambers. The disinfection-shower in-

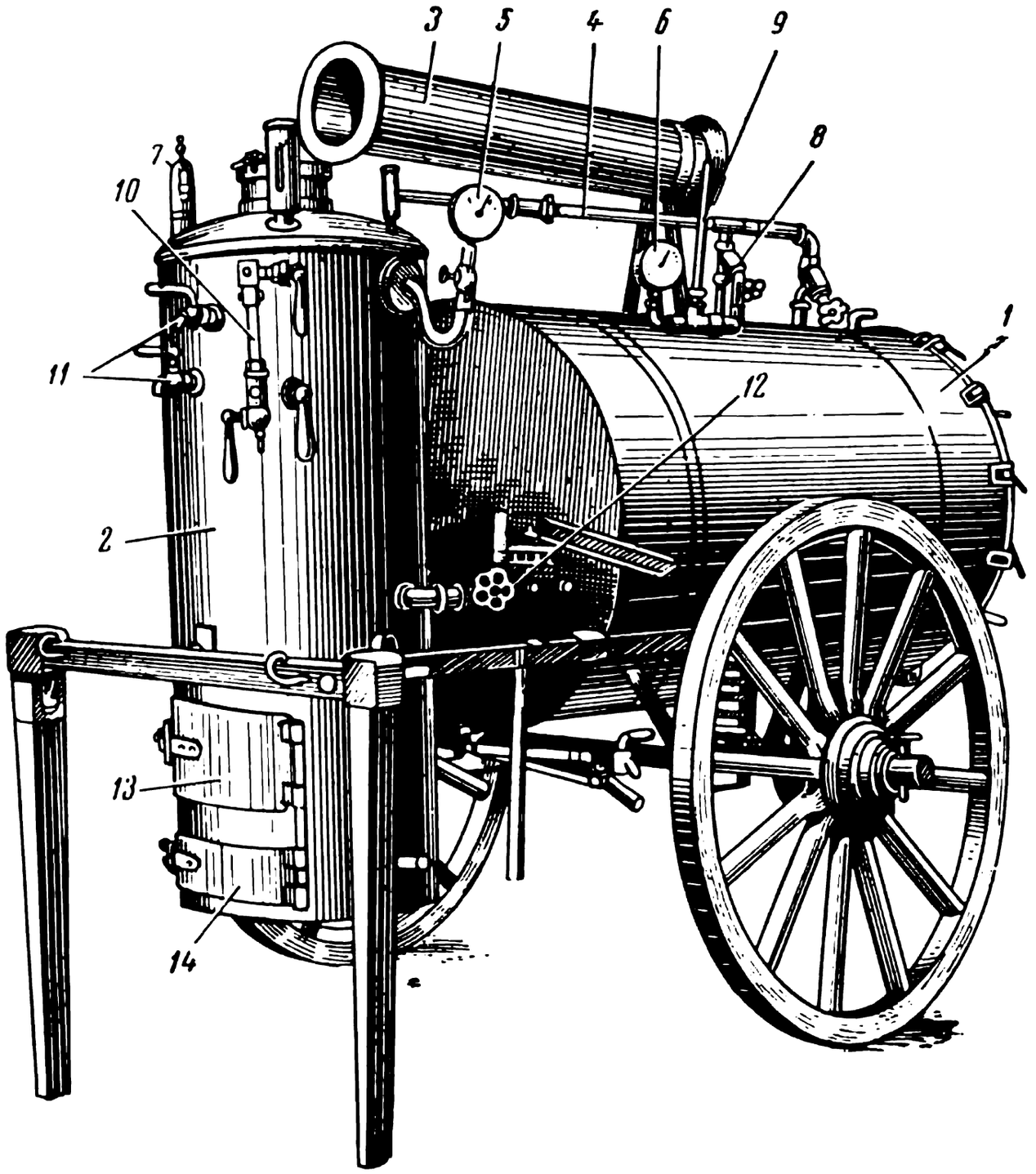


Fig. 27. Transportable disinfection steam apparatus (after V. I. Vashkov)

1—case of the chamber; *2*—boiler; *3*—chimney; *4*—steam pipe from boiler to chamber; *5*—pressure gauge on the boiler; *6*—pressure gauge on the chamber; *7*—safety valve on the boiler; *8*—safety valve on the chamber; *9*—thermometer; *10*—water level; *11*—trial tabs; *12*—pump; *13*—furnace; *14*—ash pit

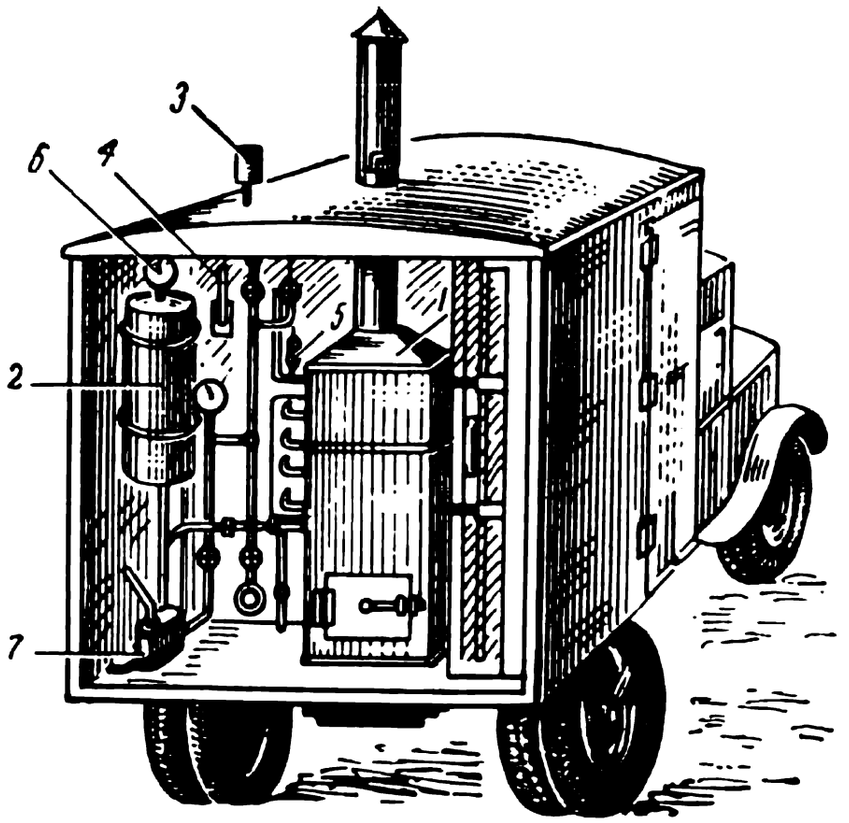


Fig. 28. General view of a portable steam-formalin disinfection chamber "АПК" (after V.I. Vashkov)

1—steam generator; *2*—air-water tank; *3*—formalin tank; *4*—thermometer; *5*—safety valve; *6*—pressure gauge; *7*—pump

stallation is a combination of the formalin-vapour chamber and shower equipment mounted on a motor vehicle. Another model of this chamber is mounted on a motor trailer.

For purposes of mass disinfection and insect destruction, public baths with disinfection chambers—sanitary inspection and disinfection posts—are organised in towns and at railroad junctions, so that large groups of the population may undergo disinfection. The same purpose is achieved by railroad carriages having combined baths, laundering, and disinfection facilities.

Planning of Prophylactic and Anti-epidemic Measures and the Network of Institutions of the Sanitary-epidemiological Service. The battle against infectious diseases, like all work of the public health bodies in the U.S.S.R., is planned. Annual, quarterly and monthly plans for prophylactic and anti-epidemic measures are drawn up by public health bodies at regional, town and district levels, on the basis of an analysis of previous morbidity rates and the tasks

by the administrative and higher public health bodies. The plans may relate to specific diseases or to all the main infectious diseases found in the given administrative area. Since the plans provide for measures to be conducted not only by medical institutions but by economic organisations and administrative organs, the integrated programmes for preventive and anti-epidemic measures are usually endorsed by the executive committees of regional, town or district Soviets of working people's deputies.

These plans and an analysis of morbidity rates in the area served provide the basis for a curative-prophylactic institution (combined hospital-polyclinic, women and children's polyclinics, medical-sanitary departments at industrial enterprises, etc.) to compile its own programmes of preventive and control measures against infectious diseases.

These programmes must make provision for sufficient isolation beds to be available when required, for adequate supplies of antibiotics, vaccines and sera, the functioning of a diagnostic laboratory, prophylactic vaccination, health education and special prophylactic measures in relation to certain infectious diseases found in the area served by a given establishment.

Besides the general medical network, the institutions of the sanitary-epidemiological service are also engaged in the prevention and control of infectious diseases. These bodies give guidance to and supervise the work of curative-prophylactic institutions and also adopt a number of independent measures: detection of carriers, observation of foci of infections, sanitary inspection, disinfection, disinfestation (insects and rats), health education, etc. The basic unit of the sanitary-epidemiological service is the district sanitary-epidemiological station or the sanitary-epidemiological department of a district hospital. In towns and regions (territories) there are town and regional (territorial) sanitary-epidemiological stations.

A sanitary-epidemiological station has four departments: sanitary, epidemiological and disinfection, and a sanitary-bacteriological laboratory. If need be, other specialised departments can be established—a department for particularly dangerous infections (to combat tularemia, brucellosis or anthrax), departments of virology, helminthology or

specialised sanitary departments—industrial hygiene, food hygiene, public sanitation and school hygiene. Big towns have disinfection centres responsible for the evacuation of infectious patients, for current and prophylactic disinfection. Anti-plague stations with branches, under centralised administration, are arranged in areas enzootic for plague.

Independent sanitary-epidemiological stations are established on the railways; sanitary-epidemiological stations or branches of territorial stations are established at sea and airports and are responsible for the sanitary protection of state frontiers.

Successful prevention and control of infectious diseases require a clear-cut differentiation between the duties of medical workers employed at curative-prophylactic institutions (hospital, polyclinic, children's consultation centre) and at sanitary-epidemiological institutions (station, department).

The attending physician is responsible for the detection of an infectious patient and for establishing the diagnosis (including laboratory diagnosis); he decides whether the patient has to be isolated and arranges his hospitalisation; at the same time the doctor forwards an urgent notification card to the sanitary-epidemiological station reporting the infectious disease, and also gives this information by telephone. Prior to hospitalisation of the patient (and throughout the contagious period if the patient remains at home), the doctor arranges for current disinfection in the focus of infection and instructs the members of the patient's family accordingly.

In this work he is assisted by the nurse who works with him. The attending physician treats the infectious patient at a hospital or at home and is responsible for follow-up and observation whenever necessary. Observation of contacts in the focus also rests with the attending physician, and he inoculates the residents (children and adults) in his area if this is not the job of a special immunological service.

The health officer (we shall use this term to describe a worker at a sanitary-epidemiological institution), upon receiving urgent notification about a case of an infectious disease, carries out an epidemiological survey of the focus,

decides upon and puts into effect measures for its liquidation.

If need be, he arranges for the contacts to undergo the necessary laboratory tests to detect carriers and investigates the environment in order to discover the routes of transmission of the disease. Following hospitalisation or recovery of a patient, the health officer and his subordinates perform the final disinfection in the focus and, together with the attending physician, keep the focus under subsequent observation. The health officer plans the vaccination of the population in his area, supplies medical workers with vaccination materials and supervises the quality of vaccination. If there is a special vaccination service in the given area, all work involved in organising vaccination is carried out by the health officer, while the selection of those who need to undergo vaccination is conducted by him jointly with the attending physician. The health officer takes care of the necessary sanitary measures and supervises the observance of sanitary rules and regulations by economic organisations.

The following research centres are engaged in the control of infectious diseases in the U.S.S.R.: institutes of epidemiology, microbiology and hygiene, institutes of vaccines and sera, anti-plague institutes, institutes of malaria and medical parasitology, the Central Disinfection Institute, the Central Institute of Biological Preparations Control and the departments of microbiology, epidemiology and infectious diseases at medical colleges and at institutes of advanced training for doctors.

The highest bodies responsible for the prevention and control of infectious diseases in the Union Republics are sanitary-epidemiological departments of the ministries of public health or republican sanitary-epidemiological stations. In the Ministry of Public Health of the U.S.S.R. this work is the responsibility of the State Central Sanitary Inspectorate. The above-mentioned sanitary bodies work in close contact with the bodies supervising the functioning of curative-prophylactic institutions. It should be borne in mind, however, that despite the existence of sanitary-epidemiological institutions, prevention and control of infectious diseases is conducted by the entire network of med-

ical institutions, by all medical workers throughout the country. Moreover, the basic work in the prevention and control of infectious diseases is carried out by doctors of the most common specialities—district physicians and pediatricians—who are the first to encounter infectious patients. Successful control of infectious diseases, therefore, depends first and foremost upon the quality of their work, upon their knowledge of the theory and practice of epidemiology.

PART TWO

Specific Epidemiology

TYPHOID FEVER AND PARATYPHOID

Etiology. Typhoid fever, paratyphoid A and paratyphoid B are infections which are similar as regards clinical picture and epidemiology. Typhoid fever is caused by *Salmonella typhi* (*Bact. typhi abdominalis*), paratyphoid A and B by *Salmonella paratyphi A* (*Bact. paratyphi A*) and *Salmonella paratyphi B* (*Bact. paratyphi B*), respectively. The agents are members of a big group of salmonellae, other representatives of which are pathogens of food-poisoning and infectious enterocolites, and of septic diseases in domestic animals. Besides the three infections mentioned, other diseases with similar clinical manifestations are caused by *Salmonella paratyphi C* and *Salmonella sendai.*

The pathogens of typho-paratyphoid infections are able to survive for a considerable time in the environment. They remain viable in feces, soil and water for a period ranging from a few days to two or three months, particularly in winter, in low temperatures, when not exposed to the sun's rays and when the activity of antagonistic microbes is diminished. In food products typhoid-fever and paratyphoid-fever bacteria not only remain viable but can also multiply (milk, semicooked meat, prepared food) and in fact only die when the products become unfit for consumption owing to the advanced stage of putrefaction. Heating to 56-60 °C kills them in 30 minutes; the same effect is achieved in a few minutes by disinfectants of a standard concentration.

Pathogenesis. The salmonellae of typhoid fever and paratyphoid fever enter the body with food or water or, most

commonly, are carried to the mouth by dirty hands. Having passed the stomach barrier with its acid medium (where they frequently perish), the microbes reach the small intestine where they find a weak alkaline medium favourable to them, invade the blood stream and spread throughout the organism, settling in the marrow, lymph nodes of the mesentery, and walls of the intestines (solitary follicles and Peyer's patches), as well as in the urinary tracts. In the course of this, the lymph nodes of the intestinal walls become necrotised and ulcerate, and the typhoid bacteria arrive at the intestinal lumen and are then discharged in feces. Typhoid bacteria may also be discharged in urine. Typhoid fever infection therefore includes a period of bacteremia (from the end of incubation to the end of the second or third week of disease) and a period of formation of infection granulomas in the lymph nodes and lymphoid tissue (beginning with the second week of the disease). The incubation period varies, averaging from seven to 21 days (usually 14 days), and in paratyphoid fever A and B from three or five days to 14 days (usually seven days). The organism gradually rids itself of the pathogen and in most patients the process is completed in two weeks after clinical recovery. Some of the patients remain carriers for two or three months, others for many years or for life (chronic carriers). Survey reports indicate that from 0.2 to 0.3 per cent of typhoid fever convalescents become chronic carriers.

Susceptibility to typhoid fever is great, though not universal. During intensive outbreaks up to 90 per cent of those infected may become ill, though as a rule the percentage is not more than 40. Most likely, some may have the asymptomatic form, becoming healthy carriers for one or two weeks. Fairly lasting immunity develops and reinfection is rare (0.7-2 per cent of cases). However, when chemotherapeutic drugs (chloramphenicol, levomycetin, synthomycin and others) are used, the patients treated develop a rather imperfect immunity and relapses are possible.

Sources of Infection. The chief sources of infection are patients who become contagious in the second week, convalescents and chronic carriers. In countries with low incidence of the disease (the U.S.S.R. and other economically developed countries) and with an efficient system of

detection and hospitalisation of typhoid and paratyphoid fever patients, the most dangerous infection sources are the chronic carriers, who are responsible for up to three-quarters of all cases. Chronic carriers can isolate bacteria in feces (biliary carrying) or less often in urine. The epidemiological significance of healthy carriers is slight if not doubtful, since the asymptomatic forms of typhoid fever are rare and the discharge of bacteria is insignificant.

Numerous cases are recorded of one carrier infecting considerable numbers of people. In New York, a cook ("Typhoid Mary") was detected in 1939 who had infected 65 people in different families in the course of several years. According to V. A. Bashenin, another cook-carrier in Orekhovo-Zuyevo, who was employed in public canteens, had infected 65 persons with typhoid fever in the course of eight years (1923-30). In 1947 we observed 12 cases in a kindergarten in Kharkov—all contracted from a cook-carrier. Chronic carriers are particularly dangerous when they are employed in public catering, the retail food trade, or in children's institutions.

Routes of Transmission. The factors involved in the transmission of the infectious agent in typhoid fever and paratyphoid fever are water and food products; a prominent route of transmission is domestic contact ("disease of dirty hands"), here a particularly important role is played by flies—mechanical carriers.

Epidemiology. There are various ways in which water may be contaminated by feces (see "General Epidemiology"), and epidemics of typhoid and paratyphoid fever vary as regards the number of cases involved, rate of development, duration, etc. In the case of massive and brief contamination of a central source of water supply, the epidemic progresses swiftly because a large number of people contract the infection simultaneously. The removal of contamination results in a sharp drop in incidence. However, since the typhoid patients become sources of domestic infection for their contacts, the decline of the epidemic outbreak is usually extended ("the epidemic tail"). Water-borne outbreaks of typhoid fever bear no relation to any particular season of the year. Prolonged and non-intensive contamination of the water supply may result in chronic water-borne epidemics.

In this case a high morbidity rate is observed throughout the year, obscuring the typhoid fever seasonal rises. From time to time there are brief rises, coinciding with more intensive contamination of water sources.

Food-borne epidemics of typhoid fever can in most cases be traced to milk and dairy products (ice-cream) or ready-made dishes like jellied meat, Russian salad, etc., which are cooked some time before they are eaten. The characteristic picture for food-borne epidemics of typhoid fever is the occurrence over 10-15 days of groups of cases among persons who have eaten contaminated food. The most common source in such cases is cooks, dairy workers, and other persons who happen to be chronic carriers.

Domestic epidemics of typhoid fever develop more gradually. As a rule, an epidemiological survey establishes a sequence in the spread of the infection (the epidemic chain). The rate of the development of incidence and the number of cases may increase sharply if there are large numbers of flies and adverse sanitary conditions.

Typhoid fever used to be a widespread disease in the U.S.S.R.; however, its incidence has dropped considerably in post-war years. The chief factors in the reduction of typhoid and paratyphoid fever incidence have been the development of centralised water supplies and the introduction of adequate sanitary protection of water sources, the development of public catering and the food industry, strict observance of sanitary rules and regulations, regular removal of sewage and waste from communities, fly control and improvement of the sanitary standards of the population. Typhoid fever now occurs mainly in places where there is inadequate sanitation and the water-supply is unsatisfactory.

Sporadic cases of typhoid fever are observed throughout the year, but the seasonal rise is confined to late summer and early autumn—August and September (Fig. 29). In view of the length of the incubation period and the time of registration of cases the typhoid-fever curve should be shifted back by three or four weeks, which limits the contraction peak to the summer season. Several reasons account for its seasonal nature. Flies are an important factor in the transmission of the infectious agent, and in summer people

are more likely to use food products (fruit, milk) contaminated by feces; bathing in rivers, etc., is also conducive to the spread of infection. All age groups are susceptible to typhoid fever but their share in overall morbidity varies with local conditions.

Laboratory Diagnosis. Laboratory diagnosis of typhoid and paratyphoid fevers is possible at all stages of the disease. The most accurate method is that of blood culture. In the first two weeks five ml of blood is withdrawn from the ulnar vein (median vein of the elbow), in the second or third week of the disease 20 to 30 ml of blood should be taken. From the second week onwards, bacteriological confirmation of the diagnosis is achieved by isolating the pathogen from feces. Analysis of feces is imperative before the patient is discharged. Discharge takes place when the results of two or three tests taken at intervals of three to five days are negative. For serological analysis (Widal's test) blood is taken at the end of the second or the beginning of the third week of the disease, and it is advisable to repeat this in order to follow the rise in antibody titre.

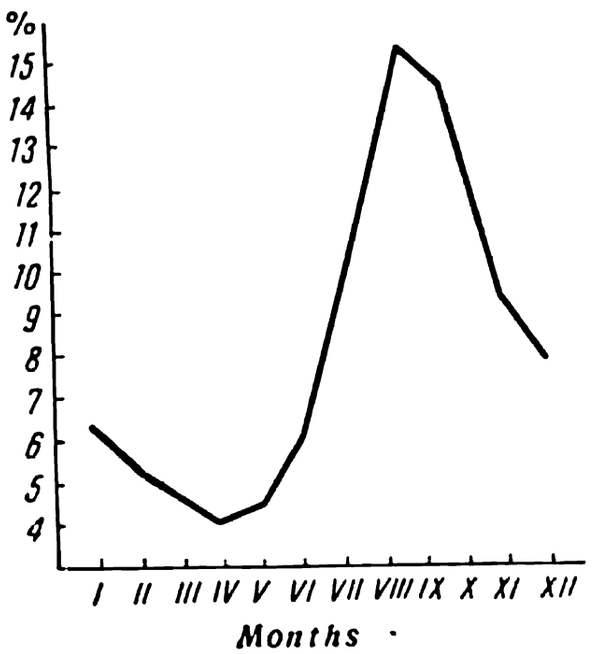


Fig. 29. Seasonal distribution of typhoid and paratyphoid cases in the U.S.S.R. (percentages to annual total)

Prophylaxis. Prophylaxis of typhoid and paratyphoid is based on general sanitary measures for the entire group of intestinal infections and specific ones for the diseases in question.

General sanitary measures include observance of proper standards of water supply, the removal and decontamination of filth, fly control, and also the observance of standards of hygiene in public catering. All these measures are introduced by the economic organisations concerned under the supervision of public health bodies. The latter are responsible for regularly testing water-supply sources and food

products (milk in particular), for general sanitary surveillance and for the implementation of carrier tests among workers in the food and catering industry, water-supply service, children's and medical institutions.

In areas with a high typhoid incidence prophylactic inoculation is recommended with triple vaccine containing killed typhoid and paratyphoid A and B bacilli, with pentavaccine, containing, in addition, killed dysentery bacilli, or mixed vaccine (a chemical vaccine with added tetanus toxoid). Initial vaccination with triple vaccine and pentavaccine is given three times at intervals of seven or ten days in doses of 0.5-1-1 ml. The first revaccination, in the subsequent year, is given twice at the same interval and in doses of 0.5-1 ml. Subsequent revaccination may be given once in two or three years in a single dose of 1 ml. Children from seven to 15 years of age are given one half or two-thirds of the adult dose. When, for epidemiological reasons, it is necessary to vaccinate children of pre-school age (from two to five) they are given one-third of the adult dose. Immunisation with the mixed vaccine is performed with a single dose of 1 ml or twice in doses of 0.5 and 1 ml with an interval of two or three weeks between. Typhoid immunisation should cover those groups of population in a given area which have the highest morbidity rate, and also food and water-supply workers, since cases amongst them are a particular danger to the community. It is advisable to immunise persons living in the same flats with carriers.

Typhoid and paratyphoid patients are subject to compulsory hospitalisation in isolation hospitals for the entire period of the disease and are discharged on the strength of bacteriological test data. The district sanitary-epidemiological station is immediately notified. A bacteriological control test is made three or four months after discharge in order to discover chronic carriers. When positive results are obtained, carriers are taken off work in food enterprises (the preparation of food), in water-supply system and children's and medical institutions. Contacts are not isolated, but are placed under medical observation for 25-30 days and are investigated bacteriologically once or twice during the period to discover carriers.

Following hospitalisation of the patient, final disinfection is carried out in the focus. Used linen and bed-clothes are soaked in one per cent solution of chloramine or boiled in a sodium-soap solution; dishes are boiled or placed in chloramine solution, food remnants, vomit and feces are disinfected with dry chloride of lime or its ten per cent solution, outer garments are subject to chamber disinfection and the premises, to humid disinfection. Fly-control measures have to be taken and further hatching prevented.

BACILLARY DYSENTERY

Etiology. Bacillary dysentery is caused by a group of similar bacilli of one genus. There are four main dysentery agents: Grigoryev-Shiga *Bacillus disenteriae*, Schmitz bacillus, Flexner bacillus (this species includes three subspecies: Flexner proper, Newcastle and Boyd-Novogorodskaya) and Sonne bacillus.

Flexner disentery bacilli have six serotypes, and Boyd-Novogorodskaya have seven. The first of the four mentioned pathogens produces an exotoxin and is the pathogen of the most severe forms of dysentery. Dysentery pathogens are somewhat less viable in environment than typhoid and paratyphoid bacteria, and remain viable in soil, water and excreta from several days to several weeks depending on the conditions. In milk and other perishable foods they retain viability for several days. Disinfectants in standard concentrations kill them in a few minutes. The most stable of the four dysentery pathogens are the Sonne bacilli, the least stable the Grigoryev-Shiga bacilli.

Pathogenesis. Contraction of dysentery occurs by the oral route. Having passed through the stomach with its unfavourable acid medium, the dysentery bacilli settle in the large intestine where they multiply, affecting the mucosa and causing inflammation and ulceration. The process may spread even to the lower section of the small intestine, particularly in children. The clinical picture may vary considerably, ranging from grave hemocolitis with intoxication to a brief enterocolitis without marked disorders of the general condition. The infectious process usually takes an acute course and terminates in complete recovery in one

and a half or two weeks. However, there may be chronic cases with relapses which may continue for many months.

The usual incubation period in dysentery is from two to five days, but in the case of a massive infection (through food) it may be shorter (12-24 hours). The patient becomes infectious with the first manifestations of the disease. The evacuation of the pathogen from the organism is gradual. In an acute form of the disease, the discharge of bacilli terminates from five to ten days after clinical recovery, but if the disease takes a protracted or chronic form, the discharge of bacilli may continue for many months, sometimes for years. Chronic forms are most frequent when infection is caused by Flexner bacillus, and are most rare when Grigoryev-Shiga bacillus is involved; Sonne dysentery occupies an intermediate position. Immunity in dysentery is of a typo-specific nature. It is particularly intensive in Grigoryev-Shiga dysentery; in other forms it is less pronounced and reinfection even with the same type of pathogen occurs fairly often.

Sources of Infection. In natural conditions dysentery affects man only, but it may be observed in monkeys held in captivity; they contract the disease from man and then spread it among themselves. Sources of infection are patients suffering from both acute and chronic forms of dysentery. Because dysentery exists in mild forms healthy carrier state is possible, or at any rate a state of infection, the clinical manifestations of which can be established only by special methods (rectoscopy). The role of those suffering from chronic dysentery is particularly great in the inter-epidemical periods, when they become the principal source of infection and perpetuate dysentery in a given area.

Routes of Transmission. The factors involved in the transmission of dysentery include food and water; flies also play a big part in spreading the disease. Water-borne epidemics of dysentery are of an explosive character and fast-spreading. Thus, the 1954 water-borne dysentery outbreak in Zaporozhye, which was caused by a breakdown of the water-mains, affected the residents of several blocks in the town and lasted for about a month. Subsequently the incidence dropped slowly because a large number of patients became sources of domestic infection (the "epidemic tail").

The explosive type of incidence is also peculiar to food-borne outbreaks of dysentery. If contamination of food has been intensive and accompanied by the multiplication of dysentery bacilli, then a dysentery epidemic may break out within a few hours and at the outset resemble a toxic food infection. This type of dysenterial toxic food infection is caused most commonly by Sonne bacilli, which are most viable and less affected by environment than other pathogens of dysentery.

However, water-borne and food-borne epidemics of dysentery are rare as compared with typhoid and paratyphoid epidemics. In most cases dysentery is contracted as a result of domestic infection, probably because dysentery patients are more contagious than typhoid patients and carriers. So undetected patients suffering from acute and chronic dysentery may be sources of outbreaks in groups of people they are in contact with. They are particularly dangerous in preschool institutions for children (nurseries, kindergartens, children's homes), where intensive contact among children who have not yet acquired hygienic habits facilitates the spread of infection. The spread of infection is also facilitated by flies.

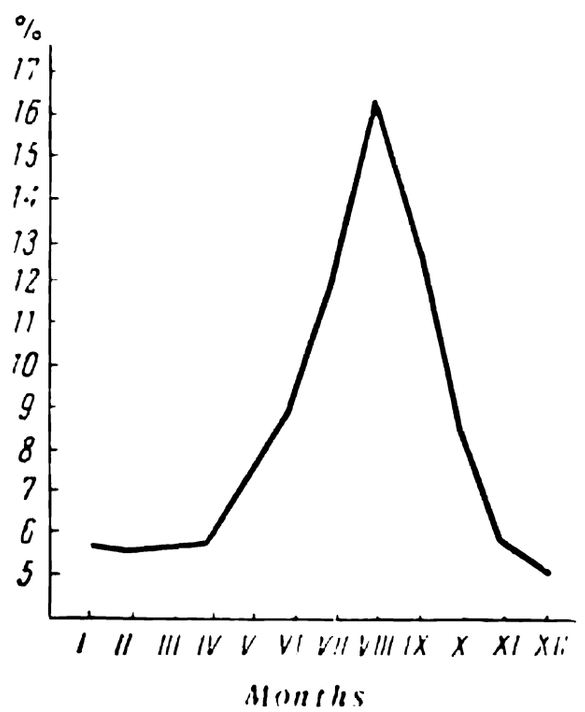


Fig. 30. Seasonal distribution of dysentry cases in the U.S.S.R. (percentages to annual total)

Epidemiology. Dysentery is spread among all age groups, but it mainly affects the younger children — from one to three years of age. The cause of this is not quite clear. Undoubtedly it is at this age that children begin to associate with one another and the possibility of contracting dysentery increases greatly. The drop in the intensity indices among the over-threes might be the result of a diminution in physiological susceptibility to dysentery and of the specific immunity to dysentery acquired by some children, and

finally because at this age children develop elementary habits of hygiene.

Dysentery has a seasonal morbidity, rising in the summer and dropping in winter (Fig. 30). The reasons for the seasonal nature of dysentery are the same as for the other intestinal diseases and the role of flies as a seasonal factor is tremendous. It has been found that the more thorough the measures of a general sanitary nature and against flies in particular, the less pronounced are the seasonal rises of incidence. Dysentery is one of the most widespread intestinal diseases and it accounts for the bulk of acute intestinal infections (see below).

Before the thirties the prevailing dysentery pathogen was the Grigoryev-Shiga bacillus, which accounted for 80 to 90 per cent of all bacteriologically detected dysentery cases. In the thirties the absolute number of dysentery cases caused by the Grigoryev-Shiga bacillus took a downward course, with a simultaneous increase in Flexner dysentery. By the end of the thirties Flexner dysentery was responsible for 70 to 80 per cent of all bacteriologically confirmed dysentery cases. This process became still more pronounced in the post-war period and culminated in the early fifties by the total disappearance of Grigoryev-Shiga dysentery in the U.S.S.R. At the same time the proportion of Sonne dysentery has increased throughout the country and it now accounts for from one-third to two-thirds of all bacteriologically proved dysentery cases. As for Schmitz dysentery, it has never occupied a prominent place in the dysentery morbidity pattern in the U.S.S.R.

There is no doubt that these developments in the etiological pattern of incidence are related to the prophylactic and anti-epidemic measures carried out in the Soviet Union; early diagnosis and isolation of patients, measures in the foci, and the considerable scope of vaccination programmes against dysentery which were launched at the time. All these measures proved particularly effective with regard to Grigoryev-Shiga dysentery, because the grave course the disease takes when it is caused by this particular pathogen makes possible virtually total detection of patients; the fact that the chronic form is comparatively rare in this form of dysentery, helped to prevent the dissemination of infection between the epidemic seasons, while well-pronounced immunogenesis ensured sufficiently high results of immunoprophylactic measures. The situation in regard to Flexner and Sonne dysentery is different. These forms of dysentery are mild and the disease frequently takes a chronic course, with resulting difficulties in total detection. Immunogenesis in these forms is so weak that immunoprophylaxis is almost completely ineffective. This is why the measures which proved to be radical in relation to Grigoryev-Shiga dysentery gave much poorer results with regard to Flexner and Sonne forms of dysentery. However, the general improvement in the people's

welfare and conditions of life and the rise in cultural standards, coupled with the anti-epidemic measures, also reduced the incidence of these forms of dysentery. Comparable data of incidence among children up to three years of age indicate that the incidence rate in the fifties was less than 50 per cent of what it was in the late thirties, although the statistics for the post-war years were much more complete.

Dysentery and Other Acute Intestinal Diseases. Dysentery is one of many acute intestinal diseases which are diagnosed, when they afflict young children, as acute enterites, colites, enterocolites and also as benign and toxic dyspepsias. Mild forms of dysentery are indistinguishable clinically from these afflictions, and the study of their nature became a problem of practical importance as far back as the thirties.

Large-scale bacteriological tests soon revealed that a considerable part of diseases classified under the above-mentioned diagnoses was of a dysenterial nature. This led to the opinion that the majority of these diseases, if not all of them, were in fact different forms of dysentery. The validity of this concept, however, became suspect in the fifties, since numerous facts began to point to the etiological role of other pathogens in acute intestinal diseases. Now we distinguish the following etiological forms of acute intestinal diseases:

1. *Bacillary Dysentery.* Besides the four pathogens described above, of which some have several serological variants, there are other bacilli belonging to the dysenterial group (*Shigella* genus) which require further study and classification. Some of them have been isolated in the U.S.S.R. (strains described under such names as "Tyakht", "Roman", etc.), others in other countries (the Large-Sachs bacilli group and others). In addition, several new serological variants in Flexner's group of bacilli have also been described.

2. *Salmonelloses.* The most widespread salmonellae cause toxic food infections (see below) but many representatives of this vast group of bacteria, which consists of several hundred serological variants, may cause acute intestinal diseases, with little difference from dysenterial diseases in the clinical picture and epidemiology. Salmonellae in the U.S.S.R. are isolated more frequently in children with

the enteritis syndrome; the following forms prevail: *S. heidelberg*, *S. breslau*, *S. newport* and so on. The detection of these diseases is only possible by bacteriological methods.

3. *Colienteritis.* Data is available pointing to the etiological role of several species of *Bacillus coli* in the development of acute intestinal diseases in young children. In this case we are not dealing with the common bacillus Coli and its varieties, which are normal inhabitants of man's intestines, but with its pathogenic varieties whose discovery and isolation has become possible thanks to the development of methods of analysis of the antigen structure of the intestinal bacilli group (*Enterobacteriaceae* family), which includes dysenterial bacilli, salmonellae, *Bacillus coli* and other similar organisms. The pathogenic intestinal bacilli have similar morphological and cultural-biochemical properties to the common intestinal bacilli; they differ in somatic antigen, which is denoted for the three most widespread varieties as 0-111, 0-55 and 0-26 respectively. As distinct from dysenterial bacteria, it is almost exclusively infants and young children (one or two years of age) that are susceptible to them. The prevailing clinical form of the disease which develops in babies infected with pathogenic intestinal bacilli is dyspepsia—toxic or ordinary. It may be stated with certainty that the majority of diseases in infants and babies which are diagnosed as toxic (and to some extent those diagnosed as ordinary) dyspepsia are caused by the three varieties of bacillus coli mentioned and this group of diseases is, therefore, called colienterites. Besides the three main varieties of coli group pathogens (*Escherichia coli* is the modern name of *Bact. coli commune*), other less common pathogenic varieties of bacillus coli are known. Apart from this, dyspepsic diseases in infants may be caused by para-intestinal bacilli (*Bact. paracoli*), of which two independent genera of enterobacteria—Ballerup and Bethesda—have been distinguished. Adults and older children do not as a rule become ill when they are infected with pathogenic intestinal bacilli, but they can be carriers and become sources of infection for infants and babies in families, maternity homes, orphanages, etc.

4. *Viral diarrhea* has been distinguished lately as an independent nosological category. The viral nature of some

outbreaks of acute intestinal diseases ("epidemic diarrhea, nausea and vomiting") was first suspected in the twenties. Since 1945, reports have been appearing of the discovery of viruses which are etiological factors of acute intestinal diseases. Most probably we are dealing not with one particular virus but with a group of viruses. In view of the wide application of tissue culture techniques, these viruses are referred to and designated as ECHO (enteric cytopathogenic human orphan) viruses and Coxsackie viruses. They are similar to poliomyelitis viruses (see below) in a number of biological and pathogenic properties. Outbreaks of viral diarrhea also occur in the U.S.S.R. Their clinical picture differs somewhat from ordinary acute intestinal diseases (the prevailing symptoms are those of gastritis and therefore the author of this textbook has described them under the heading of epidemic gastro-enteritis); sporadic cases of viral diarrhea can, however, hardly be distinguished clinically from conventional acute intestinal diseases, including dysentery of babies, and can be diagnosed by virological methods only.

5. *Amoebic dysentery*, or intestinal amoebiasis, was discovered in 1875 by the Russian scientist F. A. Lyosh, who described *Entamoeba histolytica* as the pathogen of this disease. Amoebic dysentery differs from bacillary dysentery both by its clinical picture and by its epidemiology. The infection sources are patients and carriers of amoebic cysts, and contagion more readily leads to the development of the carrier state than to the onset of the disease. Since dysenterial amoebae do not withstand drying the main factor involved in the transmission of the infectious agent is water contaminated with feces. So although sporadic cases occur in different parts of the U.S.S.R., they are confined to the southern regions (Central Asia, Transcaucasus) where the water-ditch irrigation system is used. The incidence of amoebic dysentery even in these places is rather low and on the downward trend, thanks to improvements in irrigation and the protection of water sources from fecal contamination. Besides amoebiasis, acute intestinal diseases may be caused by other species of protozoa-balantidia (*Balantidium coli*) and lamblia (*lamblia intestinalis*). As distinct from amoebic dysentery, balantidiasis and lambliasis in-

fections are mainly transmitted domestically, similarly to bacillary dysentery.

6. It is clear that some acute intestinal diseases and a considerable proportion of common dyspepsias in infants are not infectious diseases and are caused by faulty nutrition, improper care, and may also be due to overheating, which explains the prevalance of these diseases in the hot summer months. It should be remembered, however, that a considerable number of dyspepsias in newborn and breast-fed babies is of an infectious nature (salmonelloses, colienteritis, dysentery), and also that common dyspepsia of a non-infectious nature weakens the organism of a child, making it more susceptible to infection. Therefore protracted dyspepsias nearly always have an infectious etiology.

Laboratory Diagnosis. Laboratory diagnosis of dysentery and other acute intestinal diseases is of great importance, since in many cases it is the sole way of determining the etiology and establishing the differential diagnosis of this group of diseases which have similar clinical manifestations.

The most accurate diagnosis is achieved by bacteriological investigation of the feces. In view of the rapidity with which dysenterial bacteria die the best results are obtained by culturing them on nutritive media on the spot and this calls for proper training of the personnel. Only when it is impossible to sow the material on the spot are the feces sent to a laboratory, and the stool culture must be done within a period of two hours. Feces should be taken in a thoroughly washed pan, free of the slightest trace of disinfectant and rinsed in boiling hot water, and from this the feces, with particles of blood and mucosa, are drawn into a sterile jar. A more satisfactory method is the withdrawal of feces directly from the rectum by a special glass tube. Then, in accordance with the instructions of the doctor, the material is investigated in the laboratory for the dysenterial group of bacteria, salmonellae, pathogenic coli bacilli and if necessary, for intestinal viruses. The results of serological tests are less definite and the tests should be repeated, the blood being taken at the beginning of the disease, and then every seven or ten days.

Prophylaxis. Prophylaxis and control of dysentery and other acute intestinal diseases are based on general sani-

tary measures discussed in Part One of the textbook and in the chapter on typhoid fever and on specific measures.

Among the specific measures of dysentery control the most important is the adequate and systematic treatment of dysentery patients. In view of the mass nature of acute intestinal diseases, we mean not only the individual treatment of each patient, but also specific measures of an organisational nature to ensure the cure of this mass of patients and thereby suppress sources of infection. With this objective in view, all patients suffering from acute intestinal diseases should be registered at a polyclinic. When there is a considerable number of these patients, the best practice is to set up an office of intestinal diseases at a polyclinic in order to register patients, carry out diagnosis and check up on the effectiveness of therapy. Following recovery, irrespective of whether the patient has been treated in hospital or at home, the section doctor should keep the convalescent under observation for six months to determine whether cure has been complete or whether the disease has taken a chronic course. Medical observation during this period should be corroborated by two bacteriological investigations. When relapses or chronic carriers are detected the course of specific treatment should be repeated and the patient kept under observation for another six months. In this period a helminthological investigation should be performed and, if need be, a course of devastation carried out because helminthiasis is conducive to the development of dysentery into a chronic form.

With the termination of the epidemic season, in winter or in early spring, the lists of convalescents are checked. Those with manifestations of chronic dysentery are given a course of anti-relapse treatment. The basic idea of this practice is to reduce to the minimum the number of infection sources by the beginning of the epidemic season. Special courses of treatment, based on the use of antibiotics and immunotherapy, and also on the increase in the general resistance of the organism, have been worked out to facilitate the mass treatment of dysentery patients.

Those suffering from dysentery or other acute intestinal diseases may either be placed in a hospital for treatment or be treated at home. An urgent notification card

is sent to the district sanitary epidemiological station. When taking a decision on hospitalisation the section doctor should base his judgement on the epidemiological and clinical indications. The epidemiological indications for hospitalisation include unfavourable surroundings—small children in the family, a crowded flat, abundance of flies, etc. Patients at nurseries, kindergartens, orphanages, workers' and student hostels and other places where the patient may be a dangerous source of group infection, should definitely be hospitalised. From the clinical point of view hospitalisation is indicated when the disease takes a severe course and it is impossible to give adequate treatment and care at home. If the patient is left at home, the elementary rules of hygiene have to be explained to him and to those looking after him, with a view to reducing the danger of the disease being contracted by the persons around him, who should also be instructed in the simplest methods of current disinfection in the focus. When the patient is hospitalised, the focus is subjected to a final disinfection as in the case of typhoid fever. Phagoprophylaxis is another measure of a specific nature which is carried out in dysentery foci. The dysenterial bacteriophage is taken orally in doses of 3 to 5 ml for three consecutive days by the dysentery patient's contacts. Prophylactic vaccination is another specific measure taken in areas of high incidence. Pentavaccine or a mixed vaccine against intestinal infections, both containing dysenterial components, are used in these cases.

Prophylaxis and struggle against other intestinal infections is conducted along the same lines as against dysentery. Particular attention should be paid to colienterites and other diseases of newborn babies and infants. When these occur in children's institutions, attention should be paid to the observance of hygienic rules by the staff and the possibility of contagion through wrappings, dishes, toys, etc., should be totally precluded. Examinations should take place during the mornings and patients so discovered immediately isolated.

TOXIC FOOD INFECTIONS

Toxic food infections may be caused by different species of bacteria. The most important pathogens are salmonellae, staphylococci and *Clostridia botulinum.*

Salmonelloses. Salmonellae are a vast tribe of bacteria with many hundreds of species and varieties. Under the White-Kauffmann classification salmonellae are differentiated according to the structure of the antigen apparatus: O-antigens (somatic) and H-antigens (flagellar). The antigen composition of salmonellae is usually described as a formula in which Roman numerals stand for O-antigens, and Latin letters or Arabic numerals for H-antigens. For instance, typhoid fever bacteria are designated *Salmonella typhi* IX, XII, Vi : d—, paratyphoid A bacteria—*Salmonella paratyphi A* I, II, XII : a—, paratyphoid B bacteria — *Salmonella paratyphi B* I, IV, V, XII : b : 1,2, etc. The most frequent pathogens of toxic food infections are some 15-20 species of salmonellae, the most important being: *Salmonella typhi murium* I, IV, V, XII : i : 1,2 (the old name is *Bact. breslau*), *S. cholerae suis* VI, VII: c : : 1,5 (the old name is *Bact. suipestifer*), *S. enteridis* I, IX, XII : g, m (the old name is *Bact. Gärtneri*), *S. standley* IV, V, XII : d : 1,2, *S. heidelberg* IV, V, XII : r : 1,2, etc. Some salmonellae can cause not only food poisoning but typhoid-like diseases and enterocolites as has been shown in the previous two chapters. Their viability is similar to that of typhoid and paratyphoid fever pathogens.

Toxic food infections develop when masses of salmonellae enter man's organism with food. In this case they multiply in the intestine or pass into the blood stream and cause local inflammations (enteritis) and fever with general intoxication.

Most commonly, salmonelloses are zoonoses causing septic diseases in cows, pigs, sheep, poultry and rodents. Toxic food infections are usually the result of ingestion of meat and meat products abundantly infested with salmonellae. This frequently occurs in slaughter of sick animals (forced slaughtering). As a result of septicemia in these animals, when their meat is stored in warm conditions the mass multiplication of salmonellae takes place. The subsequent cooking of this meat may prove inadequate for killing the salmonellae and destroying their toxic products. This occurs for instance when large pieces of meat are boiled or roasted: in underdone beefsteaks, roastbeef, sausages, cutlets. In such cases it is a combination of intravital salmonella infection of the animal (before slaughtering), the improper storage of this meat in warm conditions, which facilitates the multiplication of bacteria, and inadequate cooking. Intravital infection can apply to eggs, duck eggs in particular, and they are a frequent cause of food poisoning, especially when they are used to make cream, melanges or omelettes. Meat may be infected after slaughtering, when the carcass is dressed or during mincing. Similarly, other food products, Russian salads, meat pastes, milk, etc., can also be infected. Sources of infection of food products may be animals, including beef and dairy cattle, rodents, poultry and human beings, if there are salmonellae in their intestines.

Toxic food infections have a brief incubation period of from four to six hours. In group and mass poisonings the disease manifests itself simultaneously within a few hours, though in some cases the disease may have a longer incubation period. Epidemiological survey is instrumental in revealing the food product which has served as the common source of infection. The survey also detects violations of slaughtering or dressing regulations if meat is in question, or violations of rules for the storage and processing of food and for the cooking or keeping prepared food products.

Salmonellae-caused toxic food infections are more frequent in the hot summer season, but may occur at any time of the year.

Toxic food infections may also be caused by other enterobacteria—dysenterial bacteria (Sonne bacillus in particular), and also by protea (*Proteus vulgaris*) and the bacillus coli (*Escherichia coli*). However, the etiological role of *Proteus vulgaris* and of *Esch. coli* in food poisoning has not yet been conclusively proved.

Laboratory diagnosis of salmonellae food poisoning is arrived at by investigating the feces, vomit and blood of the diseased, and also food remnants and prepared food to detect the pathogen. Serological tests of blood serum drawn from a patient during the disease and 10 or 15 days later to detect an antibody titre increase is also advisable. If coli or proteus poisoning is suspected, this method is the only way to obtain a correct diagnosis, since these organisms are widespread in the environment.

Salmonelloses prophylaxis consists in sanitary-veterinary surveillance of slaughtering, proper dressing of carcasses, prevention of their contamination by intestine contents, cold storage and transportation in special decontaminated packing. The most stringent observance of sanitary regulations is also imperative in culinary treatment of products, in cooking and storing of food. Raw and boiled food products should not be treated on the same working surfaces; the latter should be cleaned and decontaminated with boiling hot water after use. The kitchen staff should observe rules of personal hygiene most strictly, semi-processed food (minced meat, etc.) should not be prepared far in advance, and whenever the intervals between preparation and thermal treatment is as much as one or two hours, it should be kept in a refrigerator. It should be remembered that high standards of hygiene are the best guarantee against toxic food infections.

Staphylococcal Toxic Food Infections. Staphylococci can cause toxic food infections when there is massive multiplication in food products with the subsequent accumulation of toxins in food. The accumulation of toxins is of decisive importance and these diseases can therefore be regarded rather as intoxications than toxic infections. This also ex-

plains the brief incubation period in staphylococcal poisoning (from one to three hours, as a rule), its clear symptoms such as epigastric pains, nausea, vomiting, and its brief course of one or two days.

The source of food contamination may be either man or animal. Most often it is found to be someone suffering from purulent skin ulceration, or an animal with pathological purulent processes (cows suffering from mastitis); staphylococcal poisonings are caused most often by milk and dairy products (ice-cream, creams, pastries), but may be initiated by other products too—meat, Russian salads, fish canned in oil, etc. The conditions for the development of staphylococcal poisoning are similar to those observed in food salmonelloses (contamination of food products, warm storage, absence or inadequacy of thermal treatment).

Laboratory diagnosis and prophylactic measures are basically the same as in food-borne salmonelloses. An additional prophylactic measure is inadmittance of persons suffering from purulent ulcerations to work at food enterprises.

Botulism. The pathogenic agent of botulism is *Clostridium botulini*—spore-forming anaerobic rods producing a very strong exotoxin. Five serological strains of *Clostridia botulinum* (A, B, C, D, E) are known, of which the A, B, E strains cause disease in human beings. The toxin of the *botulinum* microbe (botulin) is destroyed by heat in 30 to 60 minutes at 80°C (in 10 to 15 minutes at boiling-point), the vegetative forms of the microbe die in 20 to 30 minutes at 60°. The spores are highly stable, survive several hours in boiling water and are not destroyed until after 20 to 30 minutes when heated to 120°C.

The pathogenesis of botulism may be reduced basically to toxin poisoning, though it may be considered proved that *Clostridia botulinum* can travel from the intestine into the blood stream and multiply in the internal organs. The incubation period is most often from 12 to 24 hours, but may extend for nine or ten days. Botulism affects the nervous system above all while disorders of the gastro-intestinal tract are usually mild, which distinguishes botulism from other toxic food infections.

The common source of infection in botulism is animals; but it may also be transmitted by people who have harmless

parasites *Clostridia botulinum* in their intestines. Owing to their stability the spores may be preserved for a long time in soil and water, from which they get into the intestines of fish. The disease affects people only after ingestion of food in which there has been prolific multiplication of *Cl. botulinum* and the accumulation of toxin. This can take place only in conditions of anaerobiosis and requires several days at least. This is why botulin-poisoning is usually connected with the ingestion of smoked or salted meat and fish (at a concentration of more than eight per cent of common salt, the development of *Cl. botulinum* is checked), sausages (the term botulism originated from the Latin "botulus", which means sausage), canned meat, fish, vegetables which have been inadequately sterilised, when conditions of anaerobiosis have developed in the thickness of the product or in canned goods.

In pre-revolutionary Russia, botulism was often a result of eating sturgeon caught by a harpoon, which had infected the muscles with the contents of the intestine; subsequent poor salting facilitated the multiplication of bacteria and accumulation of toxins. Botulism cases in the U.S.A. are in the main connected with the eating of canned vegetables; decisive in the development of the disease is soil contamination of vegetables and inadequate thermal treatment. Thanks to the observance of hygienic standards and regulations in the food industry, cases of botulism are extremely rare in the U.S.S.R.

Laboratory diagnosis is established by finding *Clostridia botulinum* and toxins in patients' feces, vomit, blood and urine, and in food products. From 10 to 15 ml of blood or urine has to be drawn for a biological botulin test. In fatal cases post-mortem examinations of sections of the stomach and intestines, blood, lymph nodes, the cortex and the spinal cord are carried out.

Prophylaxis of botulism is based on stringent observance of hygienic rules and regulations in the food industry which preclude the contamination of meat and fish by intestinal contents and raw vegetables by soil, and also on the effective sterilisation of canned goods.

In case of botulin poisoning, all persons who have eaten the product which caused the infection should be placed

under medical observation for 12 days and a prophylactic half-dose of antibotulin serum (25,000 u) injected intramuscularly; all this is in addition to the ordinary treatment (including serotherapy).

When sporadic, group or mass toxic food infections occur, an urgent notification card (or a current notice) is forwarded to the district sanitary-epidemiological station which immediately carries out an urgent investigation of the causes and take measures to prevent their spread. All suspect products are immediately withdrawn from use until the investigation is completed.

CHOLERA

Etiology. The pathogenic agent of cholera—*Vibrio cholerae*—belongs to the family of saprophytic water vibrios. Besides *Vibrio cholerae*, the cause of such diseases may be cholera-like vibrios, the best known of which is *Vibrio el-tor*. *Vibrio cholerae* is sensitive to drying but remains viable in water, humid soil and feces if the reaction of the medium is neutral or weakly alkaline. It perishes readily in an acid medium or under the influence of disinfectants.

Pathogenesis. As the *Vibrio cholerae* enters the digestive tract with food or water it finds favourable conditions in the small intestine where it multiplies rapidly, causing acute irritation and necrosis of the mucosa and affecting the vegetative nervous system, which is responsible for the innervation of the gastro-intestinal tract. This leads to increased peristalsis, diarrhea and vomiting, rapidly resulting in the radical dehydration of the organism. In many cases this algid state is followed by the second stage of the disease, typhoid cholera, a result of disbacteriosis and the invasion of intestinal microflora in the blood stream. The course of the disease may be extremely acute, but it may also vary in degree of severity, from the most acute grave forms rapidly terminating in death to obliterated forms with a subclinical course and asymptomatic infection. The incubation period ordinarily does not exceed one or two days, and rarely extends to five days. The patient becomes contagious in the final stage of the incubation period. The pathogen leaves the organism quite soon, about a week after the onset of the disease. However, a small proportion of the patients (up to five per cent) may remain carriers for

several weeks and even for two or three months. The infection is accompanied by the development of a stable immunity, and reinfection is relatively rare.

Sources of Infection. The sources of infection in cholera are patients, convalescent carriers and healthy carriers, of whom there are usually quite a number in the vicinity of patients at the time of cholera outbreaks.

Routes of Transmission. As in other intestinal infections, the factors involved in the transmission of the infectious agent of cholera may be water, food, dishes and other household objects. Flies also help to spread the infection.

Water-borne outbreaks of cholera are comparatively frequent, since the vibrio is adapted to retain viability in water for long periods of time. The outbreaks are of an explosive nature and often involve vast numbers of people. Thus, the well-known cholera epidemic in Hamburg in 1892-93, which was due to fecal contamination of the river at the point where water was drawn off for the city water-supply system, involved 19,975 people and more than 1,000 cases were recorded within one day alone. Food-borne cholera outbreaks can occur when carriers contaminate perishable products. The 1907 food-borne outbreak of cholera in Petersburg (recorded in medical literature) among the staff of a cholera hospital was traced to a cook who, while in an incubation period, contaminated jellied meat with cholera vibrios. However, as in other intestinal diseases, most infections with cholera vibrios occur by domestic contagion. Moreover, due to the brevity of the incubation period and high contagiousness of the patients, cholera outbreaks may develop swiftly, involving considerable numbers of people in a short time.

Epidemiology. Cholera does not occur everywhere. The world focus of cholera is India (Bengal) and Eastern Pakistan, where the disease has been endemic since remote times (Fig. 31). It used to spread from this part of the world to adjacent countries, travelling along the caravan and pilgrim routes. With the development of capitalism, since the beginning of last century and in connection with the progress of world trade and sea travel, cholera has repeatedly reached out to many continents, causing pandemics. Six pandemics of this type are known—in 1817-23; in 1826-37;

in 1846-62; in 1864-75; in 1883-96 and in 1902-25. The latest major epidemic which spread beyond the confines of India to Egypt, took place in 1947.

During pandemics, cholera reached Russia on many occasions and was entrenched here for many years. Thus between 1901 and 1917 there were five "cholera years" in Russia. Cases of cholera persisted in the U.S.S.R. during the Civil War and the disease was ultimately stamped out in 1925. In the post-war years a decline in cholera incidence has been noted both in India and in adjacent countries—a result of more stringent quarantine measures. However, the basic focus of cholera remains unsuppressed.

Laboratory diagnosis of cholera is arrived at by bacteriological investigation of feces, vomit and, in fatal cases, by autopsy of the intestinal contents. The material should be taken in sterile vessels, without any trace of acids and disinfectants.

Prophylaxis. Protection against the introduction of cholera into the U.S.S.R. is ensured by a complex of quarantine measures laid down by the International Convention. These measures provide for the exchange of information among countries about cholera cases, the examination of passengers arriving from an area in which there is a cholera outbreak, etc. Cholera suspects are subject to isolation in special wards of infectious diseases hospitals where strict anti-epidemic regulations are observed. Every cholera case has to be reported immediately by the doctor, who diagnoses or suspects this disease, to the district sanitary-epidemiological station and the latter has to notify higher public health bodies. Once a diagnosis of cholera is established, the contacts have to be isolated for six days for bacteriological investigation with the aim of detecting carriers of cholera vibrios. The carriers so detected should be isolated from other suspects and must not be discharged until they are cleared of cholera vibrios. The discharge of convalescents is permitted after three bacteriological tests at five-day intervals have given negative results. A thorough final disinfection is carried out in the focus, following the isolation of the patient, as in the case of typhoid fever. The staff of hospitals where cholera patients are treated must have special training, owing to the great danger presented

by this disease. A specific cholera bacteriophage is used to treat patients and carriers and to prevent the disease among contacts—15 ml once in five days orally on an empty stomach.

For prophylactic purposes an intestinal mixed vaccine, including a cholera component or a cholera monovaccine, is used. The latter is administered subcutaneously in doses of 0.5-1-1 ml at seven-day intervals. Inoculation is done if the infection has been brought in or there is a danger of its introduction to the given area. Children from seven to 14 are given one-half or two-thirds of an adult dose, children from two years of age are given one-third of the dose.

INFECTIVE HEPATITIS (BOTKIN'S DISEASE)

Etiology. Infective hepatitis has been known since ancient times; it was described by Hippocrates, but it was distinguished as an independent nosological category only in 1880-88 by the outstanding Russian clinician S. P. Botkin, who gave a classical description of the disease and pointed out its infectious origin. The etiology of infective hepatitis was established comparatively recently.

The pathogenic agent of infective hepatitis is a filtrable virus. It withstands heating up to 56°C for 30 minutes and is destroyed after an hour at 60°C. Minimal doses of chlorine used for chlorination of water do not destroy the virus if it is in water; decontamination of water is reliable if done by excessive doses of chlorine. There are no direct data on the viability time of the hepatitis virus in water, food products, sewage and on household objects. However, indirect epidemiological data indicate that the stability of the hepatitis virus in external environment is not inferior to that of the pathogens of typhoid and paratyphoid fevers.

There are grounds for believing that two antigenic varieties of hepatitis virus exist and that they have no cross-immunity. It is possible that these viruses are distinguished by other properties, such as different incubation periods of the diseases they cause.

Pathogenesis. The pathogenic agent of infective hepatitis enters the organism via the gastro-intestinal tract. The site of penetration is probably the walls of the small intestines, from which the blood stream carries the agent throughout the organism. Virological investigation indicates

that the virus multiplies chiefly in the liver tissue; the liver is most intensively attacked by the virus. Besides the ordinary route of infection via the gastro-intestinal tract, the virus may get into the blood with the inoculation of certain preparations of active and passive immunisation, and also in mass handling of non-sterile syringes and needles (inoculated jaundice, serum hepatitis).

The incubation period in infective hepatitis varies rather widely. When infection takes place via the gastro-intestinal tract it is most commonly three or four weeks, with a possible variation of between 14 and 50 days. In the above-mentioned type of parenteral infection (serum hepatitis) a much longer incubation period is recorded: most often it is two or three months, with variations from three weeks to seven and a half months.

The clinical manifestations of infective hepatitis have characteristic features. In typical cases the disease develops gradually and has three phases: pre-icteric, icteric and of convalescence. The mild forms of the disease are of great epidemiological importance, their extreme manifestation being the obliterated non-jaundice forms in which the most important symptom of diagnosis, jaundice, is absent. Epidemiological observation and virological investigation indicate that the disease may take an asymptomatic course. Thus, alongside the typical forms, in infective hepatitis there is a considerable diversity of the course, varying from grave forms (acute dystrophy of the liver) to obliterated non-jaundice forms and asymptomatic infection. Healthy carrying in infective hepatitis is apparently associated with the existence of asymptomatic infection.

These data show that susceptibility to infective hepatitis is not complete. The same supposition was proved by the observation of outbreaks of serum hepatitis when the exact number of those infected and those taken ill was established. The data recorded by different authors show that in these cases the percentage of those who became ill varied from 18 to 57. A study of these and other data gives an average index of 40 per cent susceptibility to infective hepatitis. This may vary according to the conditions prevailing.

Epidemiological observation and direct experiments point to the development of immunity in those who have survived

from infective hepatitis and that reinfection seldom occurs. The immunity remains for many years or for life and its duration and intensity may be compared with those in typhoid fever.

Sources of Infection. Multiplying in the liver tissue, the hepatitis virus re-enters the blood and together with the bile enters the intestine. Observations show that the hepatitis virus circulates in the blood during the incubation period and the first two weeks of the disease. During this period it may be isolated or its presence proved by serological reactions.

The hepatitis virus may be detected in the contents of the intestines or in the feces within two weeks after the beginning of the disease. Apparently in the majority of patients the organism gets rid of the virus by the end of this period and the patients cease to be infectious, though they still exhibit clinical manifestations of the disease (jaundice, enlargement of the liver). This circumstance explains the high incidence of infection from hepatitis sufferers in the early phase of the disease and the low infectivity of patients in the later phases of the disease.

At the same time numerous cases of virus-carrying have been observed in infective hepatitis. A study of sources of infection during outbreaks of serum hepatitis has revealed that sera containing hepatitis virus had been obtained either from former sufferers of jaundice or from healthy people who have not succumbed to this infection. These data, as well as other epidemiological observations, confirm the existence of hepatitis virus-carrying after convalescence and the existence of healthy carriers of this virus. Thus, though the contagious period in the overwhelming majority of hepatitis patients is brief and the organism gets rid of the virus prior to clinical recovery, the carrying state in some people may last for a longer period, at least for several months after convalescence.

Routes of Transmission. Infective hepatitis is a typical intestinal infection transmitted by domestic and other ordinary contact with food and water, and by flies. The comparative significance of these factors requires further study and varies in different conditions, but domestic con-

traction of the disease prevails over other modes of infection. As has been mentioned earlier, infective hepatitis infection may be also contracted parenterally (serum hepatitis).

Cases of mass incidence of infective hepatitis among people inoculated with live yellow fever vaccine were described in 1934-44. Similar outbreaks of infective hepatitis were observed after inoculations had been carried out against mosquito fever with vaccine which incorporated human serum; after passive immunisation (serum prophylaxis) against measles and epidemic parotitis, and also after transfusions of blood, plasma and serum. In all these cases the source of infection for the vaccinated people was the blood, plasma or serum of donors who were carriers of the hepatitis virus.

There have also been outbreaks of infective hepatitis associated with the mass handling of inadequately decontaminated syringes and needles. Particularly large outbreaks of infective hepatitis were observed in England among luetic patients who had been given injections of arsenous preparations. It was revealed that a minute amount of blood or lymph can get into the syringe during an intramuscular injection. When the needle is replaced without the syringe being sterilised, the blood is injected into other persons with the preparation, so that when the people treated include carriers of infective hepatitis, their blood can transmit the virus to other persons receiving the injections. Outbreaks of this type, when the infectious agent is transmitted by syringes and needles, have also been observed in connection with injections of antibiotics, during subcutaneous injections of vaccines, during the withdrawal of blood by Franck's needles, etc.

Epidemiology. Infective hepatitis is found all over the world, and in the U.S.S.R. throughout the country; it occurs more often in urban communities than in rural areas. Morbidity is sporadic, epidemic outbreaks are infrequent. The affliction rate among different age groups varies: it is the highest among pre-school children over one year of age, and also among persons of between 20 and 40 years old. There is no definite connection between infective hepatitis and particular occupations or professions.

The morbidity rate of infective hepatitis is uneven throughout the year and is similar to that of typhoid fever and intestinal infections (Fig. 32). It may be assumed that the flies which are to a great degree responsible for the rise in intestinal diseases during the summer are an important factor in increasing the incidence of infective hepatitis in the summer and autumn.

The study of infective hepatitis morbidity rates in the U.S.S.R. and other countries points to the domestic mode of contraction, in which flies are the most frequent means of transmission. When we pass from analysis of total morbidity data for a region or town to that for separate foci, outbreaks and epidemics, we find certain characteristics related to the specific features of sources of infection in infective hepatitis.

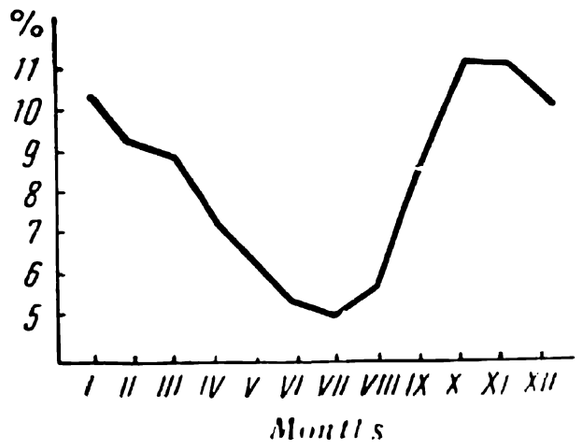


Fig. 32. Seasonal distribution of infective hepatitis cases in the U.S.S.R. (percentages to annual total)

Since the incubation period in infective hepatitis is a lengthy one, while the contagious period in most cases is relatively brief, cases occur in the form of isolated groups separated by intervals of two to four weeks (Fig. 33).

Food-borne outbreaks of infective hepatitis have been often described in medical literature. Their distinguishing feature is that the outbreak of a group of cases is confined to a brief period within the range of the possible incubation period (not more than two or three weeks) and that there is a common source of food responsible for the contagion which ordinarily occurs simultaneously. The role of food in the transmission of infective hepatitis is clearly underestimated and food-borne outbreaks of infective hepatitis are more frequent than it has been recorded. There is a description of a water-borne hepatitis epidemic in a camp of children displaced during the war from Europe to the U.S.A. There were 573 children in the camp and 350 were taken ill. The outbreak had two peaks: one, five

or seven weeks after the opening of the camp and then, four weeks later; the second wave could have been connected with contact contagion. The causes of the swift development

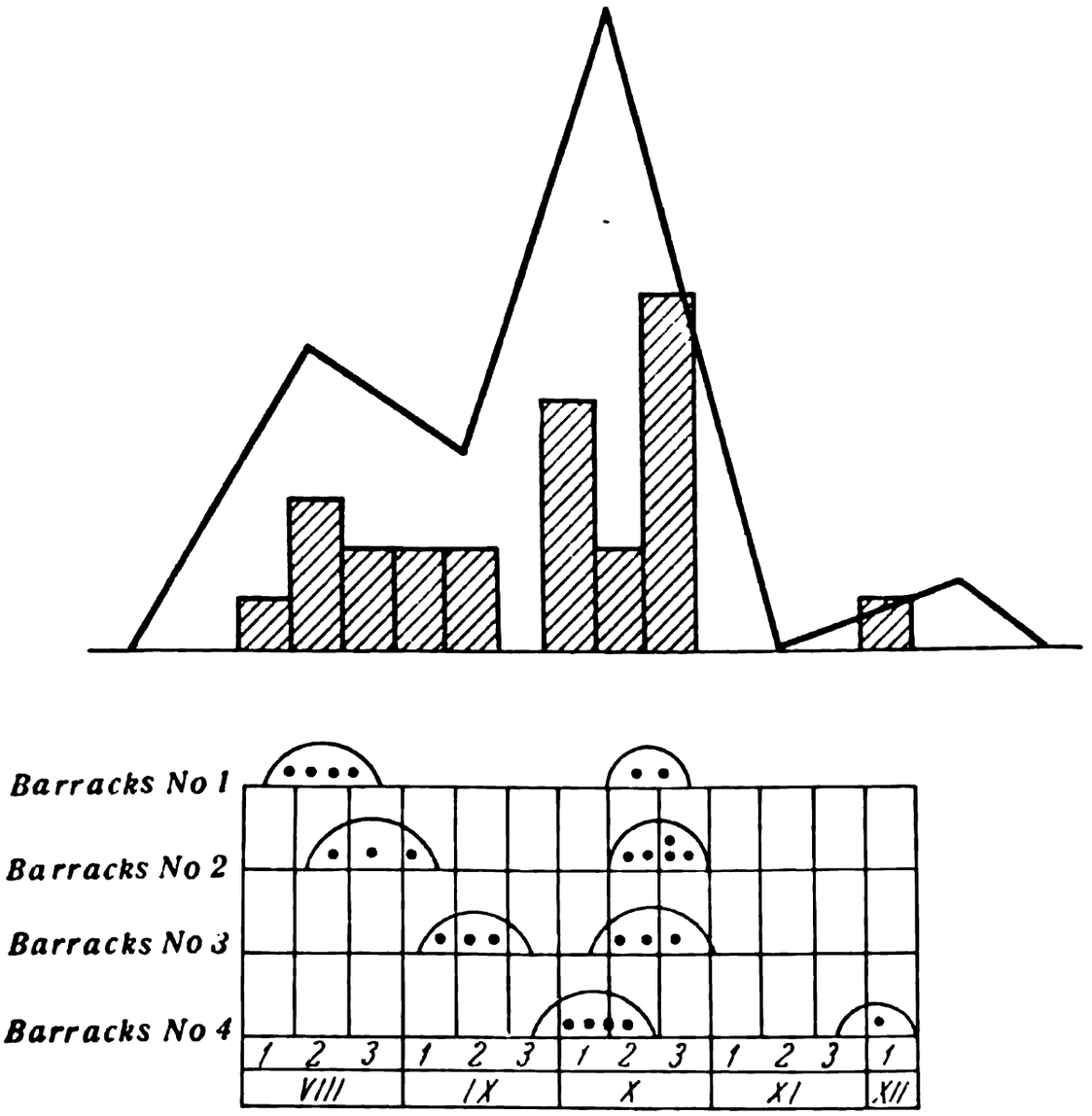


Fig. 33. The development of an infective hepatitis outburst in a collective

Points—hepatitis cases, columns and curve—total morbidity

of the epidemic and the surprisingly high incidence among children (61 per cent of all present in the camp) were inadequate sanitation and massive fecal contamination of the water source.

The connection between Botkin's disease and wars was noted even in the past century and the disease itself was known as "war jaundice", "field jaundice", etc. The biggest epidemics of Botkin's disease occurred during the first

and second world wars. During World War One epidemics of hepatitis occurred in all the belligerent countries.

World War Two was accompanied by another wave of infective hepatitis in all the belligerent countries, and particularly in their armies. The first big outbreaks of hepatitis took place in 1938 among the German troops which had occupied Spain. The concentration of Allied Forces in the Mediterranean region was accompanied by a rise in hepatitis incidence in several garrisons (Palestine, Malta). The beginning of active military operations was marked by the appearance of big epidemics of hepatitis among the troops, especially among the German troops occupying France, Norway and the Balkan countries. Particularly vast epidemics of Botkin's disease developed among the German and Anglo-American troops in North Africa and the German troops temporarily occupying a number of areas in the U.S.S.R. Typhus fever, dysentery and infective hepatitis were the most widespread diseases among German troops in the Volgograd (former Stalingrad) area. There were vast epidemics of Botkin's disease in those years in the rear of the belligerents. No exact statistics of infective hepatitis incidence for those years is available. However, it would not be an exaggeration to say that the spread of infective hepatitis during World War Two acquired a pandemic character.

There was a rise in the incidence of infective hepatitis during those years in the U.S.S.R. also, both among the field troops and in the rear. The incidence, however, did not become pandemic in the Soviet Union since the outbreaks were suppressed by the anti-epidemic service both at the front and in the rear. Bigger epidemics of Botkin's disease were observed only in the areas liberated from German occupation, and they were liquidated in the early post-war years.

Prophylaxis. Prophylaxis and control of infective hepatitis are based on the principles elaborated for other intestinal diseases with due account for the specific epidemiological features of Botkin's disease.

Early detection of patients suffering from infective hepatitis is the responsibility of the local network of public health bodies. A patient suffering from infective hepatitis

is subject to compulsory hospitalisation in the infectious diseases wards of a hospital. The doctor is obliged to report every case to the local sanitary-epidemiological station immediately, to keep contacts under observation and carry out current disinfection.

The hepatitis patient has to be placed in the department for intestinal infections of an infectious diseases hospital, but should preferably be segregated from patients suffering from other diseases of this group (typhoid fever, dysentery). The routine in the wards and departments where the hepatitis patients are placed should be the same as in the case of other intestinal diseases (typhoid fever, dysentery). The patient is kept in a hospital until there is clinical recovery and disappearance of symptoms of the disease (jaundice, inflammation of the liver, increased content of bilirubin in blood and of urobilin in urine), but not less than 15 days after the onset of the disease. Patients discharged after recovery should be kept under observation by polyclynics or children's institutions for a period of not less than six months. Infective hepatitis convalescents who are employed in children's or food institutions or in waterworks, are permitted to resume work a month after complete clinical recovery, which is checked by the above-mentioned objective data.

An epidemiological survey should be carried out in the focus where the patient has been detected to reveal the source of infection, the means of transmission and the confines of the focus. For instance, the possibility of parenteral infection by inoculations has to be investigated and it has to be determined whether the patient has been given injections or treated with blood preparations and whether the patient or members of his family are blood donors; if so, the blood transfusion centre has to be notified. When investigating possible sources of infection it should be borne in mind that they may be patients having the anicteric forms of Botkin's disease. If the disease originated in a children's institution, the staff and their families have to be examined. The measures taken to check the spread of the disease depend on the findings of the epidemiological survey.

Current disinfection has to be carried out in the focus, where the hepatitis patient has been discovered, prior to

his hospitalisation, and the final disinfection takes place following hospitalisation.

Before the patient is taken to a hospital he should be placed in a separate room and contact with other people should be reduced to the minimum. All dishes used by the patient should be used by him only, his dirty linen and underwear should be collected in a separate container. The floors in the sick room should be washed daily with water containing soap and soda. If the contents of the bedpan are spilt on the floor, the place must be washed with a three per cent chloramine solution. The bed clothes and underwear are decontaminated by one per cent chloramine solution or by boiling. The excreta of the patient should be kept for one hour covered with chloride of lime to four-fifths of the volume and then disposed of in the usual way; the same thing is done with the remains of food. The medical utensils and dishes are disinfected by boiling, and when and if this is impossible they must be left for 30 minutes in a 0.2 per cent chloramine solution, after mechanical cleaning. All flies in the sick room must be destroyed.

When the patient is taken to the hospital the final disinfection is carried out.

The patients' excreta, dishes and underwear are disinfected as in current disinfection. Floors, doors, bed and furniture are disinfected by washing. The bed clothes and objects which cannot be disinfected at home are taken away for chamber disinfection.

The toilet in the house is disinfected and if there is a latrine in the yard it also has to be disinfected and cleaned out. In addition to the disinfection, fly-control measures have to be taken. The focus in which the patient with infective hepatitis has been discovered is placed under medical supervision for 40 days from the time of the last contact with the diseased.

The supervision is carried out by the district doctor and an epidemiologist. During this time it is necessary to discover whether any of the contacts have contracted the disease. It is necessary to detect those who have at an early stage of the disease and maximum attention should therefore be concentrated upon the early manifestations of the disease. Medical observation has to be supplemented

by health-education work. Those working in children's institutions, in food industry and in waterworks have to be watched with particular care.

When infective hepatitis makes its appearance in children's institutions (nurseries, kindergartens) the group in which the case has been discovered is segregated for 40 days from the day the diseased child is isolated; new children are not admitted to this group and no transfers are allowed from it to other groups or institutions for 40 days. The medical observation of a children's institution (group) should be particularly thorough to ensure the early detection of possible sufferers.

Sanitary-prophylactic measures in infective hepatitis are carried out in the same way as in typhoid fever (sanitary observation of food, water-supply, decontamination and removal of sewage, fly control). Active immunisation is not carried out, since no adequate vaccine has as yet been discovered. Available data indicate that passive immunisation (seroprophylaxis) by gamma globulin is useful. Gamma globulin is given to children who have been in close contact with a person suffering from infective hepatitis, in the same doses as in the prophylaxis of measles.

Another important measure of prophylaxis is thorough selection of donors whose blood is used for transfusions and for preparation of anti-measles sera. When donors are chosen, their detailed epidemiological anamnesis and that of members of their families have to be compiled. Those who have had infective hepatitis are allowed to give their blood only six months after convalescence provided the bilirubin content in the blood is normal. To detect possible mild cases of infective hepatitis among donors their blood is checked for bilirubin content. If an increased content of bilirubin is found their blood is not used. The aldolase test is also recommended in these cases. In mass inoculations and also in investigations involving withdrawal of blood, the syringes, needles, pipettes and other instruments have to be sterilised by boiling each time they have been used.

POLIOMYELITIS

Etiology. The pathogenic agent of poliomyelitis is one of the small viruses and is classed with the group of intestinal viruses. Polio virus is viable in external environment. It remains viable in feces at 0-4°C for several months, in food products (milk, butter) and in water at room temperature, for several weeks. It is resistant to desiccation. The virus is killed in 30 minutes if heated to 56°C. Antibiotics and chemodrugs now available are ineffective against the polio virus.

The only laboratory animal susceptible to poliomyelitis is the monkey. Various tissue cultures are used to isolate and cultivate the virus: monkey kidneys, He La cells, etc.

There are three known serological variants of the poliomyelitis virus, types I, II and III.

Pathogenesis. The name of the disease (*polios*—grey, *myelos*—marrow) indicates that it is characterised by inflammation of the grey matter of the spinal cord, mainly the anterior horn cells. The pathological process may also involve the posterior horn cells, the stem, subcortical nuclei of the cerebellum and sometimes the cortex. These lesions determine the clinical picture of poliomyelitis in its severe form—the development of flaccid atrophic paralysis.

The pathogen enters the human organism through the digestive tract. The polio virus can also enter the body through the respiratory tract, for instance via the tonsils and the lymph nodes of the pharyngeal ring. Thus the seats of penetration of the virus in the organism are confined to the small intestines and the upper part of the respiratory

and digestive tracts. The development of the disease in a polio-infected organism is facilitated by overfatigue, trauma and intestinal lesions. Poliomyelitis has been observed to develop, for instance, after tonsillectomy. The digestive tract (the pharynx, small intestine) is not only the point of entry, but the site of initial multiplication of the virus. The subsequent spread of the virus throughout the organism and its penetration into the central nervous system, in particular, occurs through the nerve fibres; there is another theory that it is spread through the blood and the lymphatic systems. The virus is found in the spinal cord and in the medulla of the patient; not so frequently in the brain, the walls of the small intestine and the tonsils; and seldom in the blood and the cerebro-spinal fluid (CSF). The virus is discharged from the infected organism in feces for one month after the onset of the disease and possibly for much longer periods, up to three or four months and even more. As a rule, in the initial stage of the disease the virus can be isolated from the nasopharyngeal content. However, there are data indicating that the virus may persist for long periods in the lymph nodes of the nasopharynx. The incubation period is most commonly 7-14 days, with fluctuations either way.

Clinical symptoms of poliomyelitis are varied. The following forms are distinguished according to localisation: meningeal, meningeal-radicular, spinal, bulbar, forms with the involvement of the facial nerve, with the development of ascending paralyses—all these forms belong to the group of paralytic poliomyelitis. At the same time there are abortive and non-apparent forms of the disease which make up the group of aparalytic poliomyelitis. Observation confirms the existence of asymptomatic infections in poliomyelitis. Different authors give varying data on the comparative frequency of the forms since the diagnosis of aparalytic poliomyelitis presents great difficulties. Many authors consider that the number of aparalytic cases is 3-5 times as great as the number of paralytic ones.

Susceptibility to poliomyelitis is far from universal: in most cases infected people develop the asymptomatic form, becoming healthy carriers; a smaller number of people have the mild form without the development of paralyses

and only a small proportion of all sufferers develop the form with well-marked clinical symptoms. Susceptibility to poliomyelitis may vary, depending on external influences.

Convalescents develop life-long immunity. Repeated attacks are rare and are mostly caused by a different strain of virus.

Sources of Infection. Patients are particularly contagious in the first month of the disease. The discharge of the virus from the organism is gradual and some convalescents remain carriers for several months.

As a result of the polymorphic nature of the clinical manifestations of poliomyelitis, the sources of infection are sufferers from paralytic and aparalytic forms of poliomyelitis, convalescent carriers and healthy carriers. Epidemiological investigation shows that all three groups of infection sources—patients, convalescent carriers and healthy carriers—are important factors in the spread of polio infection.

Routes of Transmission. It has been recognised that poliomyelitis can be transmitted by the intestinal-oral method and by the droplet method. The chief mechanism of transmission is probably the intestinal-oral route, since the polio virus retains its viability for rather a long time in the intestine and is discharged in feces. It has also been found that water, food and flies are the usual factors involved in the transmission of polio viruses. Even the seasonal variation of polio incidence is characteristic of intestinal infections. When there is close contact, transmission by air-borne droplets is quite possible, too. The combination of both routes of transmission of poliomyelitis is responsible for the surprisingly swift progress of epidemic outbreaks which, in certain conditions, involve big groups of population within a short space of time.

Epidemiology. Poliomyelitis is found in all countries, though its distribution is uneven. Until mass vaccination was introduced, poliomyelitis was highly endemic in the economically advanced countries of Europe and in the U.S.A. Polio morbidity rate increased in the post-war years to such an extent that it was possible to speak of a world-wide pandemic of poliomyelitis. In the early fifties poliomyelitis morbidity in the United States of America

reached a peak rate of more than 60,000 cases per annum. At the same time poliomyelitis morbidity in the less developed countries was quite moderate. At first sight these facts did not agree with the theory of the intestinal-oral mechanism of the transmission of poliomyelitis, since in the countries with a high polio morbidity the incidence of intestinal infections was low, while in the countries with a high incidence of intestinal infections the number of polio cases was relatively small.

An explanation of this paradoxical phenomenon was found in the relationship between polio morbidity and the serological indices of immunity to this disease in different age and social groups of population. It was discovered that in a number of countries with relatively low indices of polio morbidity the circulation of the virus was highly intensive, so that a considerable proportion of young children contracted the disease, whose organism still had maternal immunity in the form of antibodies to poliomyelitis viruses. In these conditions poliomyelitis infection results in the development of aparalytic forms of the disease which are not recorded whereas the registered paralytic forms of poliomyelitis develop comparatively rarely. The situation is different when the circulation of polio viruses is less intensive and most infections occur in children of three or four years of age. At this age there is no longer any maternal immunity and infection frequently results in the development of the paralytic form of poliomyelitis. This explains why children of Europeans residing in colonial and semicolonial countries develop poliomyelitis more readily than the children of the local population who live in worse sanitary conditions.

This observation, of course, only partially explains the unevenness in the distribution of poliomyelitis morbidity in different countries. In fact the picture is much more complicated. One must bear in mind the varying extent to which the disease is spread in different countries, the circulation of differing serological types of the virus (causing varying proportions of paralytic forms), the developments in the immunological pattern among the population after big epidemic outbreaks, etc.

In the U.S.S.R. poliomyelitis morbidity was at a low

level for many years. However, in the mid-fifties it reached 0.8-0.9 per 10,000 of the population. Morbidity dropped radically when preventative inoculation was introduced. Poliomyelitis mostly affects children under three years of age, and to a lesser degree the older children in the pre-school age group; it is rare in the older age groups (Fig. 34).

Poliomyelitis in towns, in big cities particularly, affects children almost exclusively, specifically the younger ones, whereas in rural localities it is more frequent among the older age groups. Outbreaks have also been recorded in isolat-

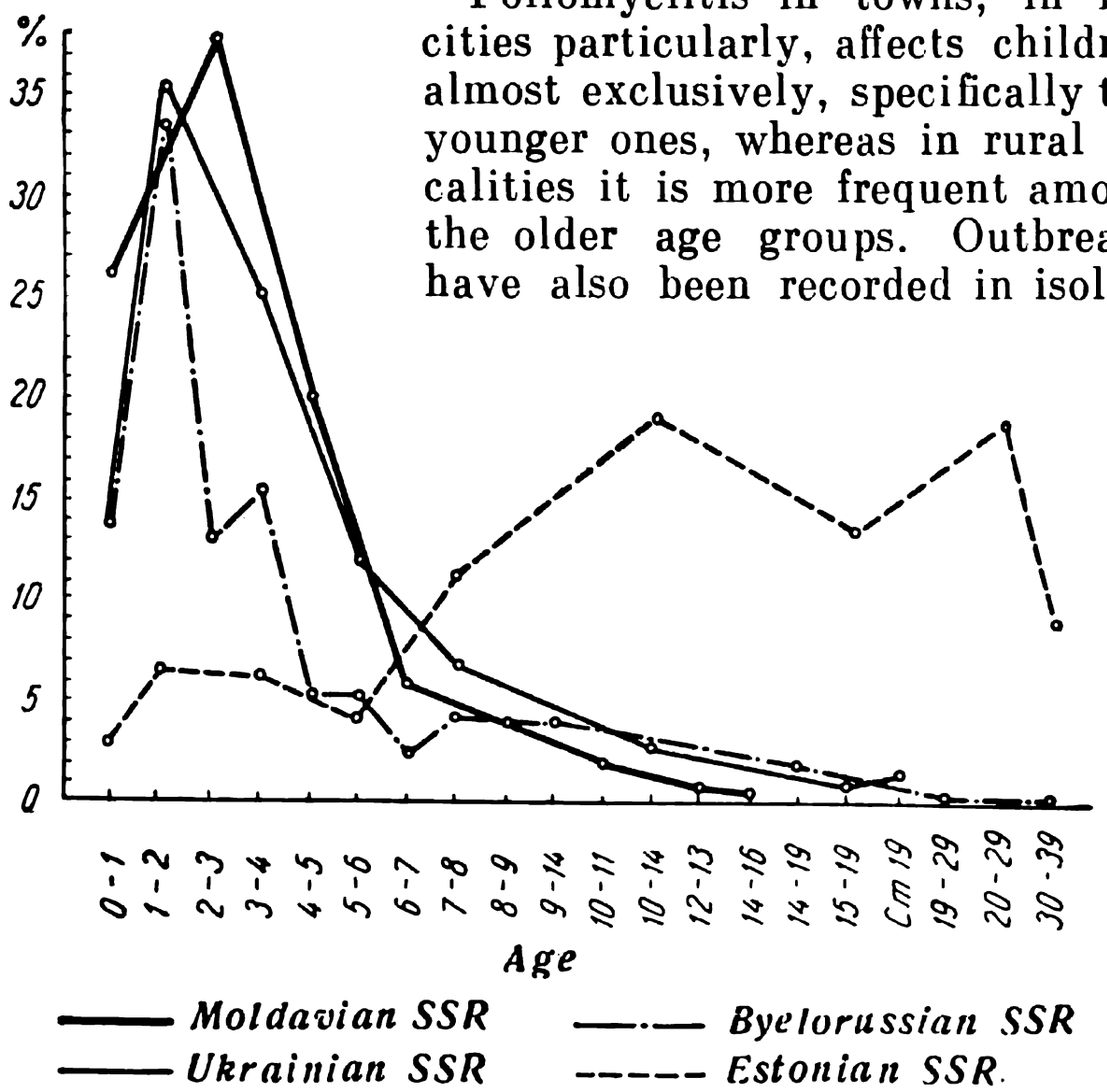


Fig. 34. Age structure of poliomyelitis cases in percentages to total (after O. V. Baroyan)

ed localities (the Pacific islands) in which the adult population was mainly affected.

The reason why poliomyelitis primarily attacks children is, as mentioned earlier, the wide circulation of the virus, as a result of which the bigger part of the population has the disease in the asymptomatic form and develops specific immunity in childhood. These considerations are confirmed by immunological studies of different age groups of the

population. It has been found that the percentage of persons with antibodies in the blood, which neutralise the virus of poliomyelitis, increases in the older age groups.

As a rule, polio incidence has the pattern of scattered cases; group cases in families and in children's institutions are the result of infection by contact. Transmission of poliomyelitis by flies has been proved both by direct recovery of the virus from flies in the foci and by indirect epidemiological observations. There are also data on poliomyelitis cases associated with fecal contamination of water sources. However, typical water-borne outbreaks, such as occur in typhoid fever have not been observed in poliomyelitis. Reliable data confirm the existence of poliomyelitis outbreaks caused by milk-transmitted infection. These outbreaks are of a violent nature and are associated with the simultaneous infection of persons who have drunk infected milk. Poliomyelitis incidence is uneven throughout the year. There is a rise in the summer coinciding with the seasonal rise in other intestinal infections (Fig. 35).

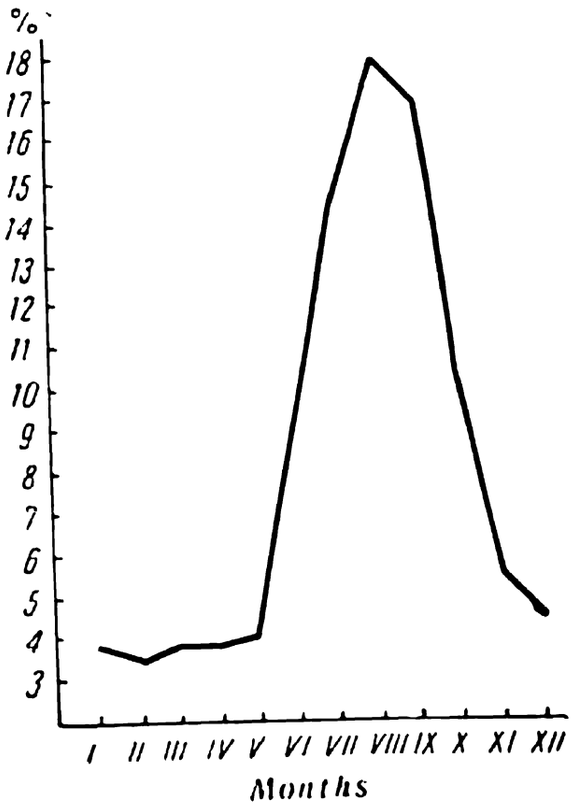


Fig. 35. Seasonal distribution of poliomyelitis cases prior to mass immunisation against poliomyelitis (percentages to an annual total)

Intestinal Viruses. The introduction of the tissue-culture method made possible the simple and easy diagnosis of poliomyelitis by isolating the virus from feces, pharyngeal swabs and pathological material, and led to the discovery of a big group of viruses which were recovered from the upper respiratory tract and the intestine. Polio and intestinal viruses in sensitive tissue cultures (the tissue of monkey kidneys, the cultures of He La cells, fibroblast cultures, etc.) cause characteristic destructions or lesions

—the cytopathogenic effect, whose specificity is confirmed by its neutralisation by immune sera against the viruses in question.

Intestinal viruses are similar to polio viruses in size, biological properties and viability in the environment. It has been found that some of them cause diseases similar to poliomyelitis in its aparalytic forms; there have been cases of intestinal viruses being isolated from patients with clinical symptoms resembling paralytic forms of poliomyelitis. Intestinal viruses may cause other diseases—herpangina, epidemic myalgia (Bornholm disease—known by the name of the island where a big epidemic of this disease occurred) aseptic (serous) meningitis, gastro-enteritis (viral diarrhea) and other syndromes of the digestive and respiratory tract, and also brief fevers, sometimes accompanied by a rash. Finally, a number of viruses recovered from the intestine are not associated with definite diseases, since they have been recovered from healthy people (mostly children). These viruses have been named "orphans", indicating that they have not yet found their diseases. This is reflected in the name of a big group of intestinal viruses (ECHO). The word ECHO is an abbreviation taken from the initials of the words "enteric cytopathic human orphans". Another group of intestinal viruses has been called Coxsackie, after the name of the place where they were first discovered. The following working classification of intestinal viruses has been suggested:

1. Viruses of poliomyelitis, serological types I, II, III.
2. Coxsackie viruses divided into two groups A and B and numbering 24 serological types. Coxsackie viruses cause diseases similar to poliomyelitis (paralytic and aparalytic), herpangina, epidemic myalgia, aseptic meningitis, viral diarrhea, brief fevers affecting the digestive and the respiratory tracts. Most of these viruses are pathogenic for suckling mice (from one to three days after birth) and this distinguishes them from the next group of viruses.
3. ECHO viruses numbering 24 serological types. ECHO viruses cause diseases similar to poliomyelitis (non-paralytic or mildly paralytic forms), infectious exanthemas (similar to German measles), aseptic meningitis, brief fevers causing disorders in the digestive and the respiratory

tracts. A considerable number of ECHO viruses have been isolated from healthy persons and their pathogenic properties are still being studied.

Intestinal viruses have been discovered in sporadic cases and during epidemic outbreaks, some of which have been considerable. Thus, the epidemic of myalgia on Bornholm Island in the forties, and another of aseptic meningitis in Siberia in 1958 involved thousands of people. There are records of numerous smaller outbreaks, mainly involving children.

The pathogenesis and epidemiology of the diseases caused by Coxsackie and ECHO viruses are similar to those in poliomyelitis but still require further study. The carrying of intestinal viruses is extremely widespread: they are shed from the intestine much more frequently than polio viruses. Moreover, isolation of intestinal viruses is more frequent in children than in adults who, as a rule, have the appropriate antibodies in the blood serum. Most probably a considerable part of the population come into contact with these viruses in childhood and acquire immunity, usually as a result of asymptomatic infection and less often as a result of a clinically manifested disease.

Laboratory Diagnosis of poliomyelitis is based on the tissue-culture method. The virus is looked for in feces, pharyngeal swabs and section material; the detection of carriers is particularly successful when feces is investigated. All these materials after treatment with antibiotics are planted in test tubes with tissue cultures. The virus is revealed by the cytopathic effect in the tissue culture. The classification of polio viruses and their differentiation from other intestinal viruses is based on neutralisation of the cytopathogenic effect by specific immune sera.

Sera obtained at the onset of the disease and in the convalescence phase are taken for serological investigation and added to the tissue culture in a mixture with standard strains of polio or intestinal viruses. In positive cases an antibody titre increase as compared with the serum taken at the onset of the disease is observed in the serum taken during the convalescent phase.

Prophylaxis. Prophylaxis and the battle against poliomyelitis are conducted in keeping with the principles elabo-

rated for other intestinal infections with due consideration for the specific epidemiology of poliomyelitis.

It is compulsory for polio patients to be hospitalised and placed in an isolation ward or separate cubicle at an infectious diseases hospital.

In exceptional cases, when living conditions are favourable and good care of the patient is ensured, he may be left at home. The physician who diagnoses or suspects this disease is in duty bound to notify the district sanitary-epidemiological station immediately. If there have been several polio cases in a given locality, early diagnosis of the disease by clinical examination of suspects is essential, the proper evaluation being made of clinical or epidemiological data available. Polio convalescents are not discharged from hospital until 40 days after the onset of the disease. Polio patients are subjected to a stringent routine similar to that observed in intestinal and droplet infections.

Following hospitalisation of the patient, final disinfection takes place. The excreta of the patient, tableware, toys and underwear are treated as in immediate disinfection. It is advisable to soak underwear in a three per cent chloramine solution for 30 minutes. The clothes of the patient and the bedding are sent away for chamber disinfection.

If there is a latrine in the yard, it has to be disinfected and cleaned out. The floors, doors and the furniture are decontaminated by wiping with a wet cloth. In addition to disinfection, fly-control measures have to be taken in the focus and fly-hatching sites must be destroyed.

Children who have associated with the patient should be segregated for 20 days, and this applies also to adults working in children's institutions, public catering establishments, milk kitchens and other food enterprises, and in waterworks.

The sanitary-prophylactic measures in poliomyelitis follow the pattern of those taken in other intestinal infections (sanitary supervision of food, water-supply, cleaning and removal of sewage, fly control).

Prophylactic vaccination is important in the prevention of poliomyelitis.

Two types of vaccine are in current use for prophylaxis of poliomyelitis: the killed vaccine prepared by J. Salk and the live vaccine prepared by A. Sabin.

The Salk vaccine is prepared from polio viruses grown on monkey kidney-tissue culture and subsequently rendered harmless by weak concentrations of formalin. The ready preparation is polyvalent, incorporating all three types of virus.

Primary vaccination consists of two doses of 1 ml of vaccine, administered intramuscularly at an interval of two to four weeks; a single dose revaccination should be administered in four to eight months. The use of the killed vaccine cuts polio incidence among vaccinated 75 to 80 per cent and considerably diminishes the rate of stable paralyses and fatal cases. Immunity is effective for two or three years and then reinoculation is advisable.

The Sabin type vaccine is prepared from strains of attenuated polio viruses grown on monkey kidney-tissue culture, but is used in the live form. The prepared vaccine is preserved at a temperature of —70° C. Primary vaccination is done orally (in the form of syrup or sweet) with monovalent vaccines of types I, II and III separately with a two-week interval between each vaccination, or also orally and with a two-week interval in two doses of trivalent vaccine, incorporating all three types of the virus. The revaccination schedule should apparently be similar to that of the Salk vaccine; it is advisable to use the polyvalent vaccine for revaccination in one or two doses. The effectiveness of the Sabin vaccine is higher than that of the Salk vaccine if vaccinations are carried out between the epidemic rises, but it is reduced considerably if they are performed during the epidemic season. The reason for this is that the presence of big numbers of intestinal viruses in the digestive tract and their interference handicaps the implantation of the polio-virus vaccine strains and the development of immunity.

Credit for the approbation and large-scale introduction of the live vaccine against poliomyelitis in the U.S.S.R. belongs to Soviet scientists M. P. Chumakov and A. A. Smorodintsev who proved the safety of the vaccine proposed by the American virologist A. Sabin and developed methods

for its mass manufacture and administration. Other types of live antipolio vaccines (Koprowski and Cox vaccines) have not been used in our country.

Large-scale vaccination against poliomyelitis led to a radical drop in the polio morbidity rate in the U.S.S.R. and to complete eradication of this infection in a number of republics. At present a mass vaccination programme is in progress to eradicate poliomyelitis throughout the Soviet Union.

Prophylaxis of the diseases caused by other intestinal viruses (ECHO and Coxsackie) is at the moment poorly developed. The measures taken in the foci and anti-epidemic measures should be similar to those taken in poliomyelitis. No specific means of prophylaxis have been elaborated.

BRUCELLOSIS

Etiology. The pathogenic organisms of brucellosis are three similar bacteria: *Br. melittensis* (goats), *Br. abortus* (cattle) and *Br. suis* (pigs), parasitic in these animals. They have similar biological properties, possess cross-immunity and are distinguished by minor biochemical and cultural differences. Their pathogenicity for man and animal also differs. Brucellae are rather resistant in the environment and survive in soil (manure) for several weeks. They remain viable for particularly long periods in milk and dairy products: for one and a half or two months in fermented milk and in locally made cheeses and other dairy products. They are destroyed by high temperature within the usual periods (heating at 60°C in 20 or 30 minutes) and by disinfectants in standard concentrations within a few minutes. However, it should be borne in mind that the survival time of brucellae is extended in the presence of protein substances contained in the excreta with which the brucellae enter the environment.

Pathogenesis. The portal of entry is ordinarily the gastro-intestinal tract, where they are introduced with food by contaminated hands. At the same time brucellae can enter the organism through skin abrasions after contact with infected excreta of brucellar animals. The brucellae enter the blood stream, settle in the internal organs and multiply there. The incubation period lasts for two or three weeks. The development of infectious foci in the spleen, liver and other organs maintains the bacteremia in the

acute phase of the disease. The resultant specific immunity gradually leads to the elimination of the pathogen from the organism, but the disease sometimes takes a protracted course and is accompanied by remissions and aggravations with long-lasting residual phenomena.

Sources of Infection. Brucellosis is a zoonosis. Three forms of brucellosis are distinguished according to the pathogen and the reservoir of infection: brucellosis of goats and sheep, brucellosis of cattle, and brucellosis of pigs. The first form of brucellosis is sometimes called epidemic brucellosis owing to the high virulence of *Br. melitensis* and the high susceptibility of man to this form. As distinct from the brucellosis of sheep and goats, the infection of man with brucellosis of cattle does not normally lead to the development of a clinically manifested disease but to an asymptomatic infection. Brucellosis of pigs occupies an intermediate position. In animals, brucellosis as a rule takes a prolonged course, the brucellae being shed with urine and milk. Brucellosis is the cause of abortions in animals, the abortive feti being rich in brucellae and extremely infectious. Human beings suffering from brucellosis present practically no danger to those surrounding them.

Routes of Transmission. Two forms of epidemic brucellosis are distinguished: an occupational disease of those tending animals and an alimentary (food) infection of people consuming milk and dairy products. Occupational brucellosis is found in shepherds, milkmaids, veterinary surgeons and other groups of the rural population. Infection may occur throughout the year but is most frequent in spring, in the pre-lambing and lambing season, when the brucellar animals become particularly contagious. Occupational brucellosis is also to be found at meat-packing enterprises and in particular at slaughter-houses. Alimentary infection with brucellosis may involve the urban population who consume milk, locally made cheeses and other dairy products. Therefore, cases of brucellosis may occur throughout the year, but are particularly frequent in the spring and summer.

Epidemiology. In the U.S.S.R. brucellosis is found mainly in the goat and sheep breeding areas (Fig. 36).

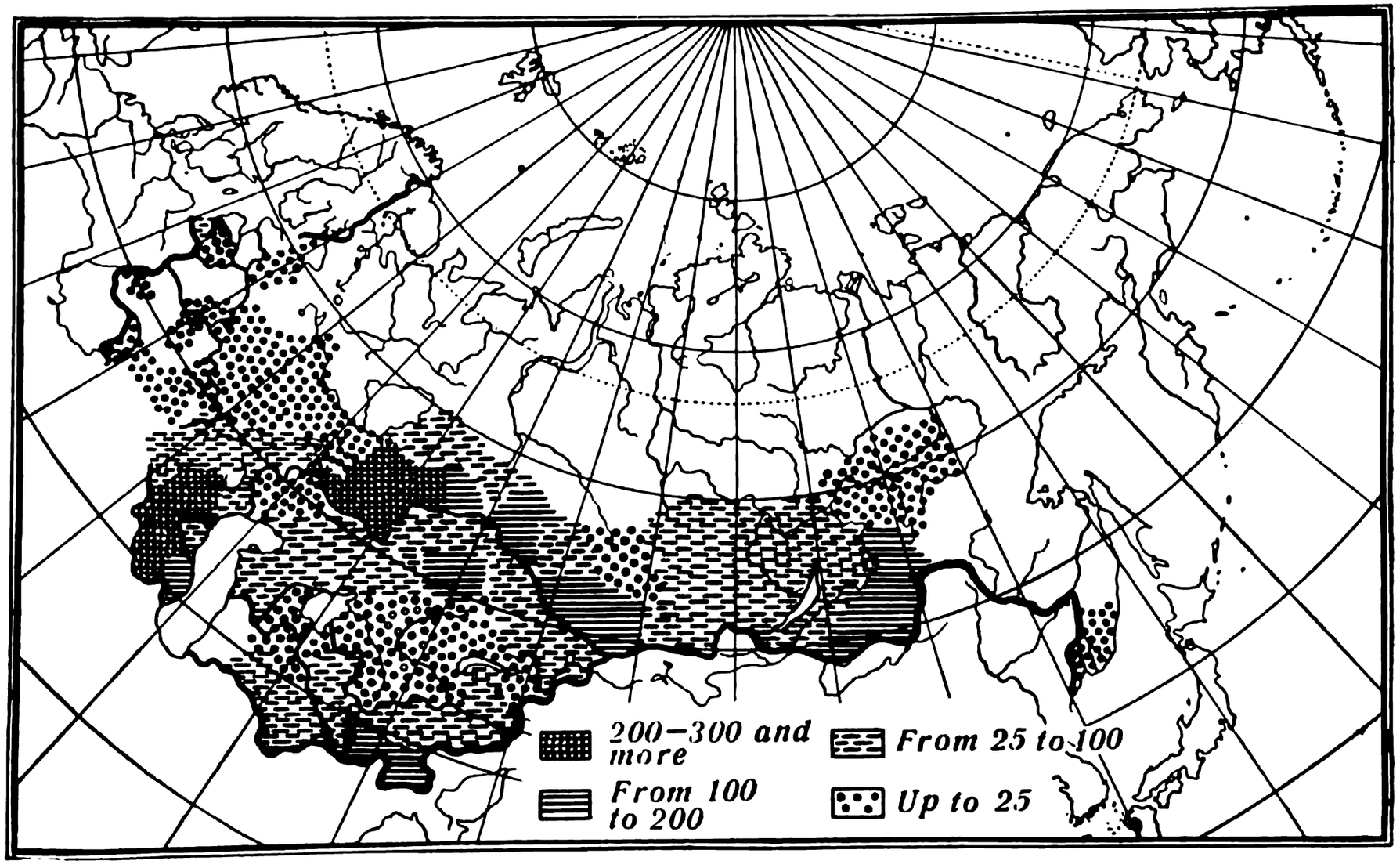


Fig. 36. Distribution of brucellosis in the U.S.S.R. (after P. A. Vershilova)

Morbidity is of a sporadic nature with a spring-summer rise. Approximately two-thirds of all cases occur as a result of occupational infection. In the post-war years, with the introduction of large-scale veterinary-sanitary measures and anti-brucellosis inoculation of the population (Fig. 37), there has been a marked downward trend in the morbidity rate of the disease.

Diagnosis. Brucellosis diagnosis may be established by isolating the culture of brucellae from sick people and animals. This method, however, takes a great deal of time and is not completely reliable. A much more accurate method of diagnosing brucellosis in humans and animals is the agglutination of brucellae by the blood serum (Wright's reaction) and the allergic intracutaneous Burnet test. Wright's reaction can be observed from the end of the second week of the disease, and it remains positive for several months. From 5 to 10 ml of blood withdrawn from the ulnar vein (median vein of the elbow) has to be sent to the laboratory for this reaction. There are numerous modifications simplifying this reaction, of which the most frequently used is the Huddleson reaction which requires 1 or 2 ml of blood drawn from the finger. The Burnet's allergy test is made by a strictly intracutaneous introduction of 0.1 ml of antigen (melitin, brucellin) in the forearm (a fine needle should be used). For control purposes an antigen which does not contain the specific brucellar component is introduced into the other forearm. In positive cases an inflammation of an allergic nature with reddening of the skin and an infiltration develops in a day or two at the site of injection of the specific antigen.

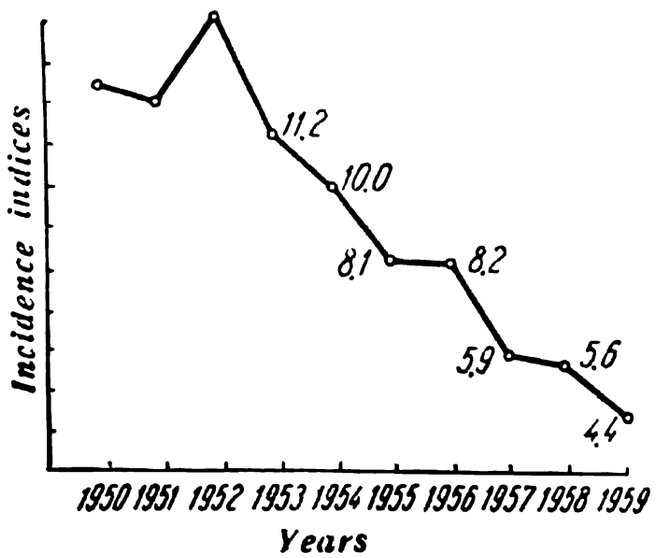


Fig. 37. Drop in brucellosis incidence in the U.S.S.R. (incidence indices per 10,000 of population)

Prophylaxis. Prophylaxis of brucellosis is achieved by the veterinary control of animal brucellosis and medical measures for preventing infection of man. The first group of measures provides for improvements in health at livestock farms affected by brucellosis, by the detection and isolation of sick animals, their slaughtering for the meat-packing industry (pedigree cattle is concentrated in specialised brucellosis farms), inoculation of animals in districts affected by brucellosis and quarantine measures to prevent the spread of brucellosis from affected farms.

Inoculation with live vaccine is carried out in order to safeguard people from brucellosis in the areas where it exists. All occupational groups engaged in livestock farming come under the inoculation programme, and if brucellosis is widespread, it covers their families and other people living in the locality. Vaccine is administered subcutaneously or epicutaneously, with specific vaccines used for each of the methods mentioned.

Subcutaneous inoculation of brucellosis patients or convalescents may give rise to severe allergic reactions or lead to an aggravation of the disease. Therefore an allergy test should first be made. Those with a positive reaction to the intracutaneous administration of the brucellar allergent need not be inoculated. The others are given 1 ml of live vaccine subcutaneously. The vaccine is manufactured in the form of a dehydrated preparation and should be diluted in sterile distilled water or a physiological solution to the volume indicated on the label.

The epicutaneous vaccine is distinguished from the subcutaneous one by a tenfold increase in the concentration of microbial organisms. The vaccine is applied to scarificated skin in the same way as in smallpox vaccination. No preliminary allergy test is required. Available data indicate that the degree of immunity resulting from epicutaneous vaccination is somewhat inferior to that of subcutaneous vaccination.

An important measure of brucellosis prophylaxis is the pasteurisation of milk for retail sale or for the dairy industry. Pasteurisation is obligatory at farms affected by brucellosis. The staff of these farms have to observe the

rules of hygiene, use special working clothes and undergo vaccination.

Brucellosis patients are subject to hospitalisation in infectious disease wards and undergo a course of specific therapy. Every case of brucellosis should be reported to the sanitary-epidemiological station immediately. Those who apply for medical help in the current year but have developed brucellosis at an earlier time are registered in the usual way. No special measures are taken with regard to contacts.

LEPTOSPIROSES

Leptospiroses are part of a group of zoonoses caused by numerous species of leptospirae differing in antigen structure which affect various species of rodents in natural conditions; some species of leptospirae find their reservoir in other species of animals (dogs, insectivorous animals). Leptospiroses are conventionally divided into two big groups: leptospiral jaundice (Weil's disease) and anicteric leptospiroses (*Leptospiroses grippotyphosa*).

LEPTOSPIRAL JAUNDICE (WEIL'S DISEASE)

Etiology. The pathogenic agent of leptospiral jaundice is *Leptospira icterohaemorrhagiae.* Icteric leptospirae are poorly resistant to desiccation and perish in a few minutes under the action of ordinary concentrations of disinfectants. Leptospirae may remain viable for weeks and months in water and may multiply if there are organic substances in the water.

Pathogenesis. The portal of entry for leptospirae in man is the gastro-intestinal tract; they enter with water and food, and also through the mucous membranes of the eye, the nasopharynx and abrasions of the skin. After entering the blood stream they multiply in internal organs, mainly in the kidneys and the liver, and are shed into the environment in the urine. In the course of the disease they re-enter the blood, causing leptospiremia. A similar pathogenesis of the disease is observed in animals which are the nat-

ural hosts of leptospirae, the only difference being that the infection is of a protracted nature accompanied by the prolonged elimination of the leptospirae in urine.

Sources of Infection. The sources of infection in leptospiral jaundice are rats. All three types of rats (*R. rattus*, *R. norvegicus*, *R. alexandrinus*) can be carriers of leptospirae. In Japan, leptospiral jaundice is spread in rice-growing areas. The reservoir of the pathogen is the field-mouse *Microtus montebelloi*. In this connection the epidemiology of leptospiral jaundice in Japan is similar to the epidemiology of non-jaundice leptospiroses (see further).

However, in most countries where this disease is associated with rats, leptospiral jaundice is spread in towns and specifically in ports.

Epidemiology. Cases of leptospiral jaundice are most commonly of a sporadic nature even when there are highly-intensive epizootics of leptospirosis among rats associated with accidental contamination of food products by the urine of carrier-rats. It is more frequent among sewerage workers who come in contact with sewer waters contaminated by leptospirae. However, when there is a considerable increase

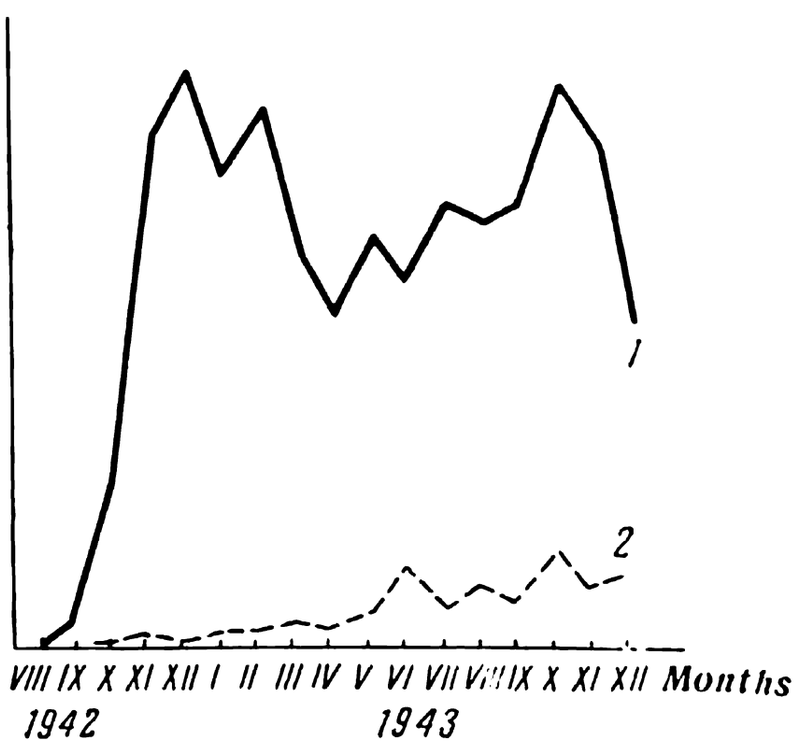


Fig. 38. Dynamics of morbidity of infectious (1) and catarrhal (2) jaundice in Leningrad (after K. N. Tokarevich)

in rats and their contact with people is intensive, the incidence may reach the proportion of epidemic outbreaks. This was the case in 1942-43 in besieged Leningrad (Fig. 38).

Diagnosis. Leptospiral jaundice is diagnosed on the results of bacteriological and serological investigation. In the acute phase of the disease blood should be sent to the laboratory for bacteriological investigation and in the convalescent phase, urine.

Serological investigation is commenced from the second week of the disease.

Prophylaxis. The prophylaxis of leptospiral jaundice is based on regular extermination of rats, protection of water sources and food products, proper maintenance of the water-supply and sewerage systems. Workers who come in contact with sewage should observe the rules of personal hygiene, use special clothes, rubber boots and gloves.

Patients suffering from leptospiral jaundice are subject to hospitalisation. Destruction of rats in the focus is advisable. No specific measures are taken with regard to contacts.

ANICTERIC LEPTOSPIROSIS

(*Leptospirosis Grippotyphosa*)

Etiology. At present several dozen species and varieties of leptospirae causing diseases, similar in their clinical course and distinguishable only serologically, have been described. Some of these species are found in the U.S.S.R. The most common are *Leptospirae grippotyphosa*. The pathogenic agents of anicteric leptospirosis are similar to icteric leptospirae.

Pathogenesis. The pathogenesis of anicteric leptospirosis is similar to that of leptospiral jaundice. The main distinction is that the lesion of the liver is less considerable and jaundice is comparatively rare. The incubation period lasts 6-12 days; the leptospirae are isolated from the blood in the first week of the disease and are eliminated in the urine during convalescence. Man, however, is of no epidemiological significance as a source of infection.

Sources of Infection. The primary reservoirs of leptospirae in nature are many species of small mouse-like rodents, in the main voles: the common field-mouse (*Microtus arvalis*), the vole (*Microtus oeconomus*), the water-vole (*Arvicola terrestris*) and certain species of small insectivorous animals. There are natural foci of anicteric leptospirosis in many countries, which differ only in the species of the leptospirae and the animal reservoirs of the pathogen.

Of no less importance as a source of infection are the secondary reservoirs of the pathogen—cattle, goats, sheep and pigs. These contract the infection in natural foci of leptospirosis, become sick and turn into carriers of leptospirae, shedding them in the urine over a period of up to six months. Infecting one another at watering-places and on pastures, these animals become important reservoirs of leptospirae. These secondary foci of leptospirosis can exist independently.

Epidemiology. Man is infected in the natural foci of leptospirosis when drinking water contaminated with leptospirae, or when bathing in infected water reservoirs (hence the frequent use of the name "water fever" to denote the disease). The portal of entry is the mouth, the mucous membranes of the eye, the nasopharynx and skin abrasions. It is also possible to contract the disease through handling cattle which are carriers of leptospirae.

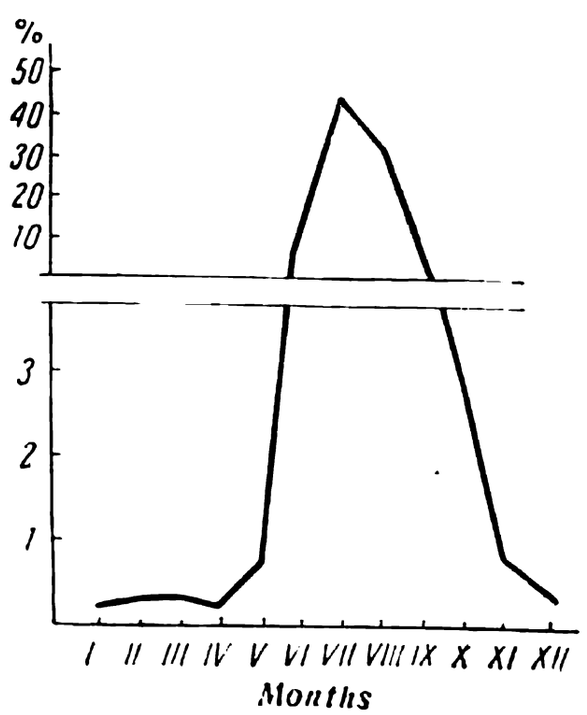


Fig. 39. Seasonal distribution of anicteric leptospirosis morbidity in the U.S.S.R. (percentages to annual total)

The indicated characteristics of the mechanism of infection are responsible for specific features of the epidemiology of anicteric leptospirosis. The disease occurs mostly among the rural population engaged in field work: haymowing in marshy localities, harvesting ("hay-mowing fever"). In addition, the disease is contracted by children

and adults who bathe in reservoirs contaminated by leptospirae. Epidemic outbreaks involving dozens and hundreds of people over a short period frequently occur, they are strictly seasonal, coinciding with hay-mowing (late spring) and harvesting (late summer). Sporadic cases of infection associated with the tending of cattle may be observed throughout the year (Fig. 39). In southern countries most outbreaks of anicteric leptospirosis occur in rice paddies (Indonesia, Italy). Laboratory diagnosis is similar to that in leptospiral jaundice.

Prophylaxis. The prophylaxis of anicteric leptospirosis is most effective when measures are taken to exterminate field rodents. Reclamation measures are also effective. People working in localities which are natural foci of anicteric leptospirosis should avoid drinking tainted water from suspect reservoirs; and those working in marshy areas should be supplied with rubber or leather footwear. Bathing in reservoirs into which sewage waters run or in rivers below the places where cattle are watered should be prohibited. Where leptospirosis is endemic, the population should be inoculated by the leptospiral killed vaccine proposed by A. A. Varfolomeyeva. The vaccine is administered subcutaneously in two doses of 1 ml at two or three weeks intervals.

Patients suffering from anictertc leptospirosis present no danger to their contacts and are hospitalised only on clinical indications. The district sanitary-epidemiological station is notified of cases of anicteric leptospirosis. No special measures are taken with regard to contacts.

HELMINTHIASES

Helminthiases represent a big group of infections caused by parasitic worms (helminths). Approximately 200 species of helminths which can cause disease in man have been described, but only a few are specific parasites of man, the majority being found in man comparatively rarely. The pathogens of helminthiases may be divided into four groups: flat worms (*Platodes*), round worms (*Nemathelminthes*), sharp-headed worms (*Acanthocephala*), and segmented worms (*Annelida*). The differences in their biological cycle divide them into geohelminths and biohelminths. The former develop without an intermediate host, the latter invade two or several consecutive hosts, man being one of them. Most helminthiases come under the heading of intestinal infections. The following information relates to the most important helminthiases of man.

Ascariasis. Ascariasis is caused by *Ascaris lumbricoides*, a big round worm parasitic in the small intestines of man. The eggs are excreted in feces and ripen in soil in ten or fifteen days at a temperature of 25-30°. At lower temperatures the development of eggs into larvae takes longer and at a temperature of 12°C or less it discontinues. The ripe eggs are ingested with vegetables and other food products contaminated with feces, and also with water. When in the human organism, the larva frees itself from its covering, penetrates the walls of the intestine, enters the blood stream and is carried to the lungs, then arrives at the upper respiratory tract, is reswallowed and settles finally in the intestine, where the cysts develop into mature worms.

Parasitation continues from eight to twelve months, after which the worms die.

Ascariasis is spread almost everywhere since the eggs of *Ascaris* are stable in the environment and are resistant to everything but desiccation and direct exposure to the sun's rays. Therefore, ascariasis is rarely met with in arid and hot areas. The incidence in the temperature zone is high, ranging in different localities from five to 80 per cent. The incidence among young children is higher than among adults.

Laboratory diagnosis is made by the detection of eggs in the feces.

Prophylaxis of ascariasis consists in general measures of hygiene and sanitation, the most important being the rational removal and decontamination of sewage, hygienic toilets, the proper operation of sewage farms and filtration, the thorough washing of vegetables which are eaten uncooked.

Specific devastation measures are carried out amongst groups of the population infected with *Ascaris*. The drugs used include santonin, sancophene, hexylresorcinol and oil of chenopodium. Treatment should be accompanied by special measures to exclude the scattering of feces containing eggs.

Trichocephaliasis. Trichocephaliasis is caused by the whipworm (*Trichocephalus trichiuris*)—a round worm parasitic in the blind gut and the adjacent areas of the small and large intestines. The eggs of the whipworm are excreted in feces and ripen in soil in 15-120 days, depending on the temperature of the environment (15-30°). The ova are ingested through contaminated food or are introduced by dirty hands; the larva frees itself from its covering and becomes implanted first in the Lieberkühn's glands, then several days later migrates to the blind gut where it attaches itself to the wall and reaches maturity, parasitising for a long time (up to five years).

The epidemiology of trichocephaliasis is similar to that of ascariasis. The disease is also widespread except in dry and hot areas with sandy soil. Unlike ascariasis, it is more frequently found in rural localities, mostly in areas with a warm climate, and is less frequent in the north; it is com-

mon among certain occupational groups including sewage-farm workers, gardeners, cesspool-cleaners, etc.

Diagnosis and prophylaxis of trichocephaliasis follow the same pattern as in ascariasis. Devastation is achieved by using osarsol, hexylresorcinol and heptylresorcinol.

Enterobiosis. Enterobiosis is caused by *Enterobius vermicularis*, an *Oxyuris*—small round worm parasitic in the lower sections of the small and large intestines of man. The fertilised females pass through the anus, lay their eggs in the perianal folds and perish. The eggs ripen in four to six hours and are immediately invasive. Infection takes place through the mouth, the eggs being introduced with food or by hands contaminated by the severe pruritis ani arising when the females emerge from the anus. Autoinfection of the patient is frequent, and the invasion may therefore last for many months and years, though the life cycle of the *Oxyuris* is short (three or four weeks).

Enterobiosis is universal, since it is not affected by climate or soil. It is most common among children. The degree of infestation depends on hygienic standards of the population. People working in the food industry who suffer from enterobiosis may be considerable sources of human invasion, if they fail to observe the rules of personal hygiene.

As distinct from other helminthiases, laboratory diagnosis of enterobiosis is made by analysis of a smear from the perianal folds where eggs of helminths can be found, and not of feces.

Prophylaxis of enterobiosis is based first of all upon the early teaching of habits of personal hygiene to the population. The appropriate rules should be observed most stringently by food-industry workers and staff of children's institutions. Conventional measures of general sanitation are also important.

Devastation is achieved by using sulphur, phenothiazine, gentian violet and extract from the male fern (*Aspidium Filix-mas*). It is essential for patients who have undergone this treatment strictly to observe the rules of hygiene to preclude autoreinvasion.

Ancylostomiasis. Ancylostomiasis or hook-worm disease is caused by invasion of *Ancylostoma duodenalis*, a small

round worm parasitic in the upper section of the small intestine of man. Another form of ancylostomiasis is necatoriasis caused by *Necator americanus*. The ova of ancylostomae are excreted in feces and develop into larvae 24 hours later. While in the soil, they feed on organic substances and at a temperature of 14-37°C (the optimum being 25-32°) ripen to the invasive state in five to ten days. They return to man through the digestive tract with contaminated vegetables or fruit or penetrate the skin by actively burrowing through the cutaneous covering. Subsequently, the larvae enter the blood stream, reach the lungs, arrive in the alveoli, rise to the upper respiratory tract, are swallowed and finally settle in the small intestine, where they reach maturity in one or one and a half months. The invasion lasts for several years.

Ancylostomiases are found in areas with a hot climate and a humid soil, both of which are necessary for the development of the larvae of the parasite, which is not resistant to low temperature and desiccation.

In addition to rural localities, hook-worm disease may be found in mines. Hook-worm diseases are widespread in tropical countries.

Laboratory diagnosis of ancylostomiases is made by detection of eggs of the helminths in feces.

Prophylaxis is based on strict observance of sanitary measures to protect the soil from fecal contamination. These measures should be particularly stringent on tea and other plantations and in the mines (construction of underground toilets and other sanitation) where mass invasion of workers might result. This is why all new workers, as well as those permanently employed at mines and plantations, who are affected by ancylostomiasis, are examined regularly and if found to be suffering from hook-worm diseases are subjected to devastation by carbontetrachloride or oil of chenopodium and by symptomatic treatment of the resultant anemia.

Strongyloidiasis. Strongyloidiasis is caused by intestinal *Anguillula* (*Strongyloides stercoralis*)—a round worm parasitic in the tissue of the mucous membranes of man, dog and cat. The larvae of the parasite are hatched from ova in the intestine and are shed into the soil in feces. While

in the soil, they perform the development cycle of a form of a free-living generation and hatch the generation of invasive larvae. The latter subsequently penetrate the skin, enter the blood stream, migrate to the lungs and then via the upper respiratory tract arrive in the intestine, where they reach maturity (parasitic generation). In less favourable conditions (the absence of the necessary humidity, temperature and nutrition in the soil) the free-living generation does not develop and the larvae in the soil quickly become invasive. Finally, a cycle of development is possible without a stage in the environment. In this case the larvae penetrate the blood stream from the intestine and after migrating through the lungs settle in the intestine (autoreinvasion).

Strongyloidiasis is prevalent in areas with a hot and humid climate; sporadic cases occur in the U.S.S.R. Infestation is accompanied by serious disturbances in the gastrointestinal tract. Laboratory diagnosis is performed by detection of the larvae in the feces. Prophylaxis is similar to ancylostomiases. Gentian violet is used for devastation.

Hymenolepiasis. Hymenolepiasis is caused by the dwarf tapeworm (*Hymenolepis nana*) parasitic in the small intestine of man. The eggs of the helminth, which are found in caducous segments of the parasite, are already invasive when excreted in feces. Invasion is effected with food, water and contaminated hands, and the oncosphere which develops from the egg becomes implanted in the intestinal villi in the upper section of the intestine, where in six or eight days it develops to the stage of cysticercoid, drops to the intestinal lumen and attaches itself again in the lower section of the small intestine, where it develops into an adult parasite in two weeks. In this helminthiasis, autoreinvasion is frequent because the eggs immediately become invasive; furthermore, the parasite may go through a complete cycle of development in the intestine without emerging into the environment.

Hymenolepiasis is spread throughout the world and its epidemiology is similar to enterobiasis. This disease is particularly common among children, specifically in towns. Laboratory diagnosis is made by detecting the eggs of the

helminths in the feces. Prophylaxis is similar to that employed in enterobiosis. The extract of the male fern or pumpkin seed are used for devastation.

Echinococcosis. Echinococcosis (Hydatid disease) is caused by *Echinococcus granulosus*, a tapeworm whose larval stage is parasitic in the liver, lungs and other organs of man and herbivorous animals. The sexually mature worm parasitises in the small intestine of dogs, wolves and other canines. When shed from their intestines into the soil, the eggs in the caducous segments of the parasites are invasive. Herbivorous animals are infected when ingesting grass; man becomes infected through eating contaminated vegetables or conveying the eggs of the echinococcus to the mouth with dirty hands after contact with dogs. In the intestine of man and the herbivorous animals the oncosphere liberates itself from the egg covering, burrows through the intestine and after entering the blood stream settles in the organs, where it develops into multilocular hydatid cysts. Dogs and beasts of prey are infected when eating the herbivorous animals. Man is not a factor in the spread of the echinococcus.

Echinococcosis is to be found everywhere. Cases occur sporadically and predominate among cattle-breeders and dog-owners.

Prophylaxis is based on rounding up stray dogs, the destruction of wolves and jackals, veterinary supervision over cattle-slaughtering (preventing dogs from eating the intestines of animals infected with echinococcosis), the observance of rules of personal hygiene by dog-owners, the examination of the latter for echinococcus-carrying and dehelminthisation.

Teniarhynchosis is an infestation by the beef tapeworm (*Taeniarhynchus saginatus*). In the mature phase it is parasitic in the small intestine of man and in the larval phase, in the organism of cattle. The oncosphere, containing eggs of helminths in the caducous segments of the parasite, emerge into the environment in an invasive phase. Cattle swallow them when eating grass. The oncospheres emerge from their covering, penetrate through the walls of the intestine into the blood stream and settle in the muscle tissues where they become encysted and develop

into cysticerci. Following ingestion of undercooked or raw beef containing the cysts, the coverings of the latter are destroyed by the digestive enzymes and the liberated larvae suck into the walls of the intestine and reach the adult stage in two or four months.

Teniarhynchosis is found wherever there are cattle and where beef is consumed.

Laboratory diagnosis is made by detecting eggs of the helminths in the feces.

Prophylaxis is based on sanitary-veterinary measures to prevent infestation of cattle (protection of pastures from fecal contamination), detection and thermal treatment of carcasses infected with cysts, or destruction when there is considerable infestation. The population is regularly examined for teniarhynchus infestation and detected carriers are subjected to devastation with laxatives, fern preparations, pumpkin seeds and pomegranate-tree bark.

Teniasis. Teniasis is caused by the pig tapeworm which is also called the armed tapeworm (*Taenia solium*). The adult phase is parasitic in the small intestine of man and in the larval phase, in the muscles of pigs, dogs and cats. The development cycle is the same as that of the beef tapeworm, differing only in intermediate hosts. In rare cases man is the intermediate host for the larval phase of the parasite (cysticercosis of the eye muscles or the cerebral subcutaneous tissue).

Teniasis is found in areas of pig-breeding. Diagnosis and prophylaxis are the same as in teniarhynchus infestation.

Trichiniasis. Trichiniasis is caused by the trichinella (*Trichinella spiralis*), a small round worm parasitic in the blind gut and the adjacent areas of the small intestine of man, pigs, rats and some other animals. In the larval phase the worm is parasitic in the muscles of the same species. Thus, the same organism is consecutively the host of the sexually mature and then of the larval stage of the parasite. Man is infected by eating undercooked or raw pork. The larvae which are liberated during digestion become implanted in the intestinal villi and reach sexual maturity in 48 hours. Fertilised females produce up to 2,000 larvae which are carried by the blood stream throughout the

organism and settle mainly in the streated muscles. They grow for 18-21 days and then coil into a spiral and become encapsulated. Under natural conditions the parasite circulates between pigs and rats. Man is an accidental host of the trichinella (Fig. 40).

Laboratory diagnosis is established by the identification of the encysted larvae in a muscle biopsy and the reaction

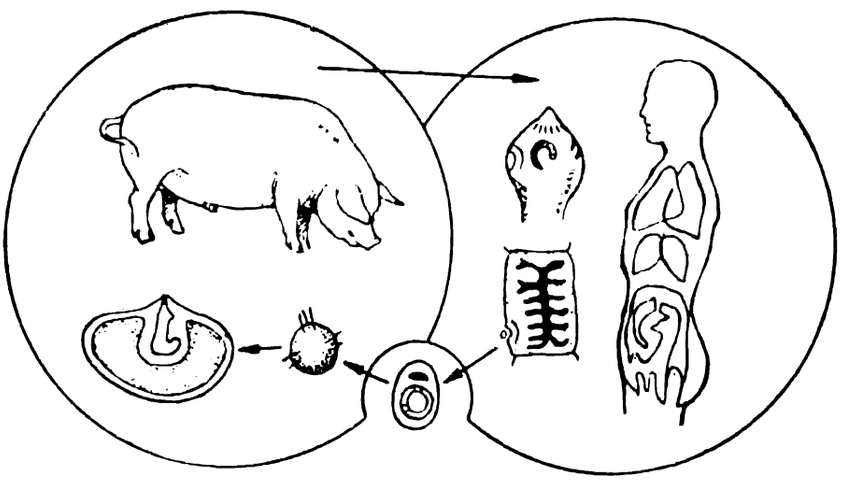


Fig. 40. The development cycle of the pig tapeworm (after K. Raška)

of precipitation of the trichinellous antigen by the serum of patients.

Prophylaxis is based on the control of rodents, the hygienic care of pigs, and sanitary-veterinary supervision at slaughter-houses with compulsory trichinelloscopy of pig carcasses.

Diphyllobothriasis. Diphyllobothriasis is caused by a tapeworm—*Diphyllobothrium latum*—parasitic in the small intestine of man, dogs, cats, pigs, seals and some other animals. The eggs of the helminth in the caducous segments are excreted in feces. They are washed by running water into reservoirs. In three or four weeks the larva coracidium matures and is swallowed by fresh-water cyclopes; it penetrates the cyclope's body and in two or three weeks develops into the second larval phase, procercoid. When the cyclopes are swallowed by fish (perch, pike, burbot), the procercoids are liberated from the digested bodies of the cyclopes and burrow through the wall of the fish intestine, penetrating the muscles and internal organs. Here they

develop into the third larval phase, plerocercoid. If fry infected by the larvae are eaten by bigger fish the plerocercoids migrate to the muscles and organs of the new host. Man and animals become infected after eating raw or undercooked fish (Fig. 41); the plerocercoids which are liberated after the digestion of the fish develop into adult parasites

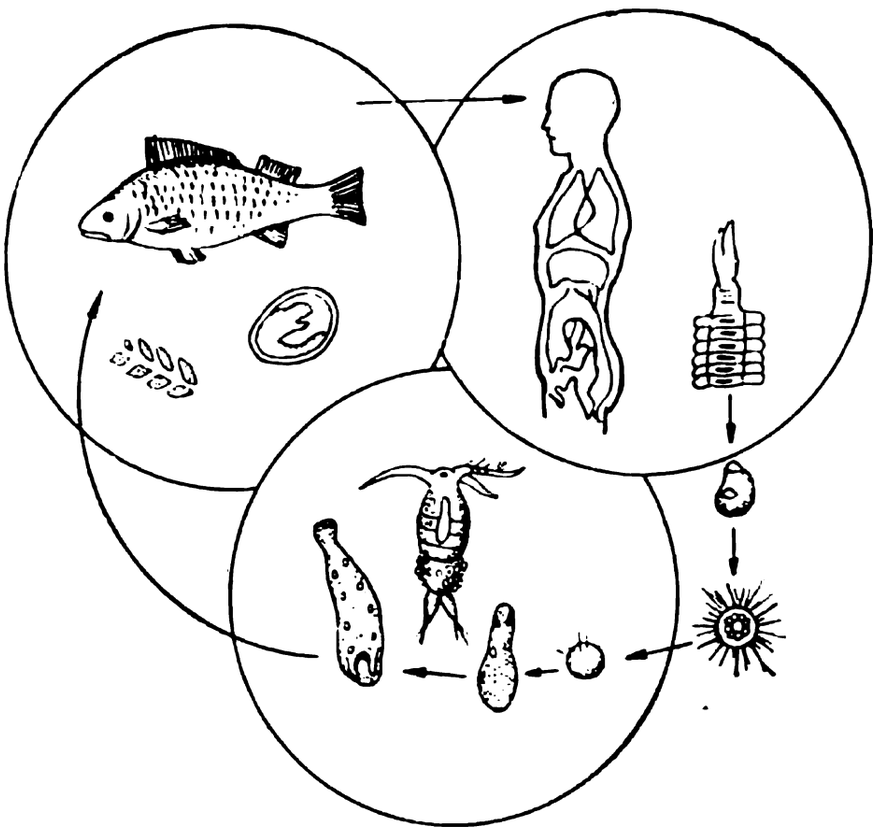


Fig. 41. The development cycle of *Diphyllobothrium latum* (after K. Raška)

in the intestine of man or animals and may survive in the organism of the final host for 15 to 20 years.

Diphyllobothriasis is spread among people living on river banks. Laboratory diagnosis is made by detecting helminth eggs in the feces.

Prophylaxis is based on the protection of reservoirs from fecal contamination, the rounding up of stray dogs and dehelminthisation of domestic animals. Raw fish must not be eaten. Devastation of population suffering from diphyllobothrium infestation is carried out by male fern and pumpkin-seed preparations.

Opistorchosis. Opistorchosis is caused by a cat fluke (*Opistorchis felineus*)—a flat worm parasitic in the organism

of man, cats, dogs and other carnivora. The eggs of the helminths arrive in the soil in feces, are washed by rain-waters into reservoirs where they are swallowed by fresh-water molluscs (*Bithynia leachi*). The miracidium—the larva which develops from the egg—penetrates the body of the mollusc and within two months develops first into the sporocyst within which redia are formed, and these develop to the stage of cercariae, which leave the organism of the mollusc and become implanted in the bodies of members of the carp family where within 24 hours they develop into metacercaria and become encysted in the muscles. Infection of man and animals takes place as a result of eating raw and undercooked fish; the larvae which are liberated during digestion arrive in the gall-bladder, the liver and the pancreas. They reach maturity in two weeks and survive for several years.

The epidemiology of opistorchosis is similar to that of diphyllobothriasis and prophylaxis is the same. Devastation is achieved by antimony sodium tartrate and hexachlorethane.

INFLUENZA

Etiology. A group of infections with a similar clinical picture but of differing etiology are diagnosed as influenza. Formerly they were divided into two big groups: viral influenza and acute catarrhs of the respiratory tracts of bacterial etiology. Subsequent research has revealed that the acute catarrhs are not a uniform infection, some are of viral, and some of bacterial etiology.

Influenza is caused by comparatively large viruses. The pathogenic agent has low resistance to environmental influences and perishes in a few hours at room temperature. When acted upon by disinfectants, exposed to direct sunlight or heated to 60°C, it perishes in five to ten minutes.

At present there are four known viruses of influenza: viruses A, B, C and D. They differ in antigen structure and do not have cross-immunity. The most widespread are the A and B viruses, particularly the A virus, responsible for the three recent pandemics.

The virus of influenza is distinguished from the other known pathogens by its variability, which manifests itself in the course of the epidemic process. This peculiarity is especially noticeable in the virus of group A. This variability relates to the virus antigen structure with which the specific immunity to influenza is associated. Considerable changes in the antigen structure of group A virus have taken place since its discovery in 1933. These changes have resulted in the appearance of several varieties of antigen: A (1933-46), A1 (1947-56) and A2 (1957 and subsequent years). Moreover, the antigen structure in these varieties has undergone slight changes every year and more or less simultaneously in different parts of the world. Finally,

within two to five years of the appearance of new varieties, those preceding them disappear.

Special research programmes in the U.S.S.R. and in other countries have revealed that the changes in the antigen structure and the immunological properties of influenza viruses are due to the peculiarities of man's specific immunity to influenza. Every influenza epidemic leads to the development of specific immunity to the given virus among a considerable section of the population. This immunity, however, becomes much weaker within a few months and the multiplication of the virus in a partially immune organism becomes possible. The presence of a partial immunity in a large section of the population means that the majority of influenza viruses repeatedly pass through the organism of immune persons and are continually influenced by this specific immunity and change their antigen structure in the process of adaptation. The accumulation of slight modification finally results in radical changes such as the development of a new virus with an antigen structure differing from that of the virus formerly in circulation. This pattern was observed, for instance, in the origination of virus A1 in 1945-47 and virus A2 in 1957. To a certain extent it has been experimentally reproduced by passing influenza virus through the organism of immune mice. Similar variability has been observed in virus B, but its development is slower and thus far has not resulted in the origination of distinct varieties of the virus.

Pathogenesis. The virus enters man's organism through the upper respiratory tract, from which it reaches the cells of the columnar epithelium. It is in these cells, mainly in the tissues of the mucous membranes of the respiratory tract, and sometimes in the pulmonary tissue, that the virus multiplies. From there influenza virus and the products of its disintegration arrive in the blood, leading to the intoxication of the organism. The virus is discharged in mucosal secretions of the respiratory tracts, in the urine and the secretion of the conjunctiva of the eyes.

The multiplication of the virus in the cells of the epithelium of the respiratory tract gives rise to grave metabolic disorders in the tissues of mucous membranes, to necrosis and exfoliation of the epithelium. The pathological process

may spread to the pulmonary tissue (more often observed in small children and old people). In this case the virus causes primary hemorrhagic pneumonia which is frequently fatal. There is no doubt that the intoxication and other pathological phenomena in influenza are associated both with the local and the resorptive action of the virus and the products of its disintegration. Associated with it are also such important symptoms as psychic depression, adynamia and drastic inhibition of the protective forces of the organism, which is manifested in leukopenia and a weakening of the phagocytic activity of leucocytes. The lowered resistance of the organism leads to the activation of the conditionally pathogenic microflora of the respiratory tract (streptococci, staphylococci, pneumococci, *Bacillus influenzae*, etc.)—the cause of the frequent complications observed in influenza (pneumonia, sinusites, otites, etc.).

In addition to the typical, clinically exhibited forms of moderate severity, there are atypical forms of this infection: severe (toxic forms, primary and secondary pneumonias) and mild forms, including inapparent forms; the asymptomatic infection, which plays a significant role in the development of immunity to influenza among the population, is also widespread.

Immunity to Influenza A lasts for two or three years, and to influenza B, for three to five years. It is possible that these immunity periods, based on the observation of the periodicity of influenza epidemics, are probably somewhat exaggerated, especially if we take into consideration the variability of the viruses in question.

Sources of Infection. The sources of infection are, therefore, influenza patients. As was mentioned earlier, the infection can take a clinically exhibited (apparent) form or inapparent and asymptomatic forms (healthy carriers). The incubation period in influenza does not exceed three days, usually taking one or two days, and at times even less. The duration of the contagious period is limited to the period of discharge of the virus with the secretion of the respiratory tract. The virus can be detected at an early stage of the disease; the peak discharge is observed in the first three days of the disease but the virus can be isolated even later (up to five, seven or nine days). In the major-

ity of patients this is the contagious period; the patient is considerably less infectious to those around him towards the end of the disease.

Routes of Transmission. The mechanism of transmission of infection in influenza is determined by the site of multiplication and the routes of discharge of the virus from the organism.

Influenza is a typical infection of the respiratory tract with the droplet method of transmission. The shedding of the virus in the urine is of hardly any epidemiological importance. As the influenza virus is extremely unstable, the most important method of transmission to immediate contacts is the droplet route. Objects recently infected by the patient, such as towels and dishes, also have some epidemiological significance. However, the role of household objects in the transmission of influenza is, in general, insignificant and the droplet method of transmission is not only the principal, but practically the only one.

Susceptibility to influenza is high; it is universal in children who have not suffered from this infection. This is seen from observations of the influenza pandemic in 1957 and of separate groups of children at the time of other epidemics: wherever there had not been timely anti-epidemic measures, all children developed the disease.

A study of the epidemics of recent decades reveals, however, that even at the time of very intensive outbursts total morbidity of the population was not observed. Not more than 15-30 per cent were affected, while the incidence during less intensive outbursts did not exceed three or five per cent of the population. Thus, only a certain proportion of the population is susceptible to influenza. This is associated with the presence of specific immunity in a large part of the population (the result of previous infection) and is entirely unconnected with the physiological peculiarities of age. A study of morbidity rates in different age groups shows that the highest incidence and, hence, the greatest susceptibility is among younger children and that there is a decline in the older age groups (Fig. 42). Nevertheless, when influenza is imported to sparsely populated areas (for instance, to remote islands), where this infection has not been observed for a long time, there is total morbidity.

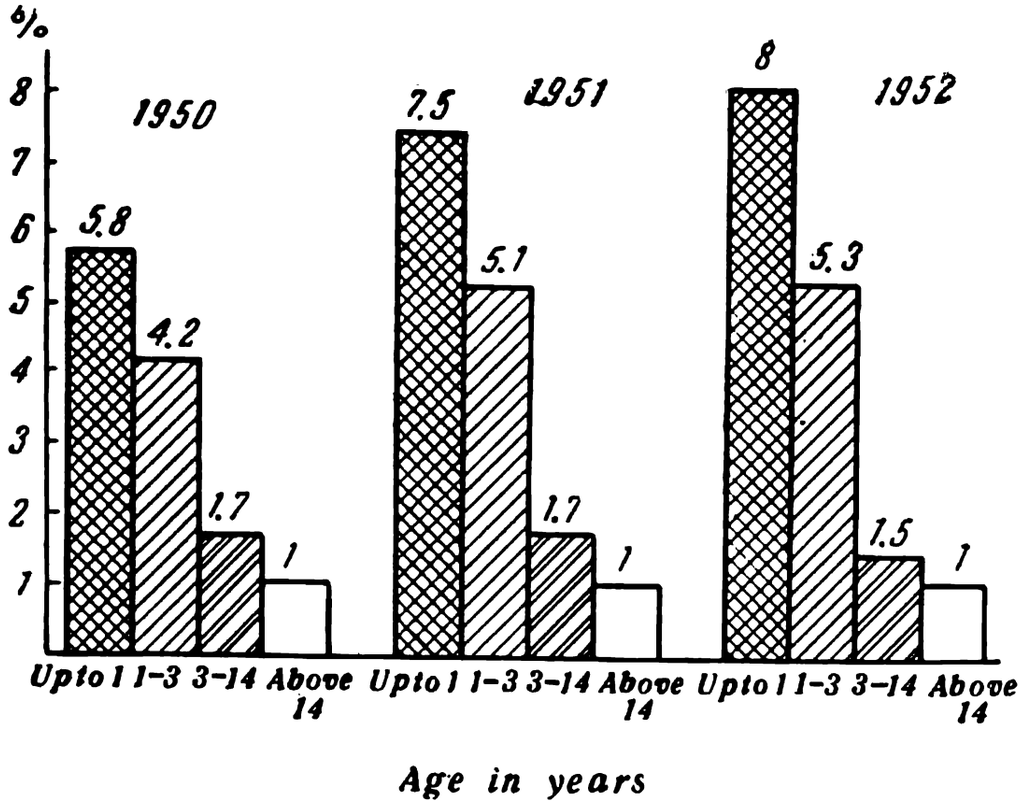


Fig. 42. Age group influenza morbidity (after V. V. Ritova)

Epidemiology. Influenza is not only a world-wide disease, but the most widespread mass infection; its morbidity considerably surpasses the sum total of all other infectious diseases.

Statistics relating to influenza morbidity are incomplete even in the U.S.S.R., where influenza cases are registered and records kept. The basic reason is that many patients, particularly those who develop the mild form, do not apply for medical assistance. Data relating to influenza incidence among insured groups of the population are more accurate. These data indicate that the annual influenza incidence is from 60 to 185 persons per 100 gainfully employed. However, even these data require checking, since a number of diseases which are in fact acute catarrhs of the respiratory tract are diagnosed as influenza.

If we take the total number of influenza cases and of acute catarrhs of the respiratory tract, the proportion of influenza in this total will vary widely, both seasonally and annually. Roughly it may be said that when there are considerable outbreaks of influenza, its share in the sum total of cases reaches 80-90 per cent; during moderate

rises of incidence the proportion is up to 40-60 per cent; when the incidence is low, it does not exceed 10-15 per cent. The average for several years would show that influenza accounts for two-thirds, and acute catarrhs of the respiratory tracts—for one-third of all cases diagnosed under these two headings. These conclusions were obtained on the basis of selective studies in which differentiated diagnoses of influenza and of acute catarrhs of the respiratory tracts were established by serological methods (Fig. 43).

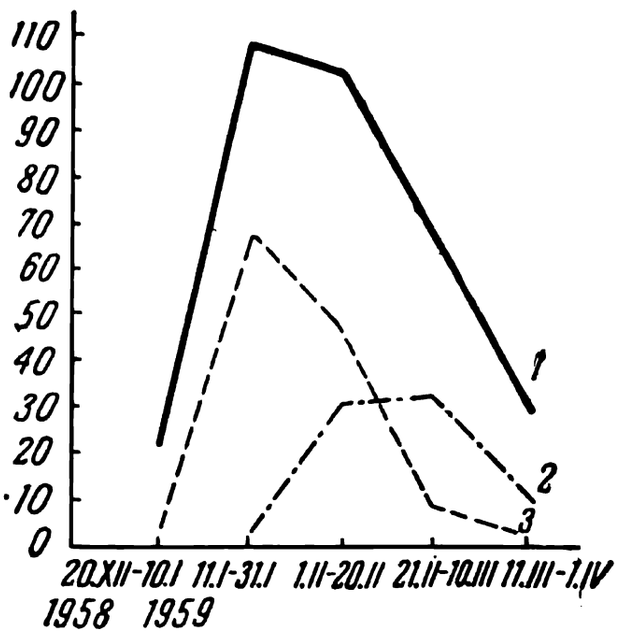


Fig. 43. Influenza morbidity in I-III quarters of 1959 in Leningrad according to statistical data and the findings of serological examination of patients (after E. A. Fridman and others)

Figures—indices per 10,000 of population; *1*—total morbidity; *2*—influenza A; *3*—influenza B

We have said that influenza is widespread in all countries; however, its incidence is higher in countries with a temperate climate than in hot countries. So far no rational explanation of this phenomenon has been found, since during pandemics influenza morbidity has been just as high in tropical countries as in the countries with a temperate or cold climate. In the U.S.S.R. influenza incidence in the Central Asian Republics and in the other southern areas of the country is considerably lower than in the areas with a moderate climate.

Influenza morbidity levels are not uniform in different occupational groups.

Attention has been drawn to the comparatively higher morbidity indices among textile workers and to the lower indices in the coal-mining industry. A number of factors should be taken into consideration when analysing the reasons for this. In particular, it must be remembered that a considerable number of cases of acute catarrhs of the respiratory tract are diagnosed as influenza. The higher mor-

bidity rate among textile workers is due to a number of circumstances, among them the presence of organic dust at the factories, which causes disturbances of the upper respiratory tracts and thus facilitates the development of acute catarrhs. In their turn, these increase susceptibility to influenza; the usual textile-mill microclimate, with its high temperature and increased humidity, also facilitates, particularly in winter, the development of catarrhs and increased susceptibility to influenza; the fact that contact among workers is more intensive than in many other industries makes for rapid spread of the infection. The comparatively low level of influenza incidence among coal-miners is explained by the lower intensity of contact among miners and by the quite important fact that workers in the coal industry are generally people who are particularly robust.

It is important to analyse the incidence of influenza and of acute catarrhs of the respiratory tract in different occupational groups in order to work out rational measures to control these infections. Specifically, better ventilation arrangements to reduce atmospheric dust and improve the microclimate at textile enterprises is an important measure for reducing influenza morbidity and that of a number of other respiratory infections.

Influenza morbidity levels are linked with the density of population, a relation which is characteristic of all droplet infections. Influenza morbidity is higher in the towns than in the countryside. Moreover, a relatively high morbidity level is observed in towns throughout the year, whereas in the countryside we find only brief outbursts separated by periods in which there are no cases whatever.

Influenza morbidity varies with the seasons of the year. There is an annual drop in incidence during the summer months and a rise in autumn, winter and spring. Three types of morbidity rises are observed: a slow rise which persists for some time at a high level and declines gradually; the influenza wave in this case is observed throughout the cold months of the year. Then there are brief and highly intensive outbursts occurring against the background of these rises and terminating within a month or two. Finally there are the pandemics.

A detailed study of seasonal rises has shown that increases in the incidence of influenza and of acute catarrhs of the respiratory tract coincide in time. Moreover, during these rises, cases caused by all strains of influenza viruses have been detected with a predominance of one of them. In contrast to this, the brief and intensive outbursts are ordinarily associated with one influenza virus.

There are a number of causes for this peculiarity in the development of influenza epidemics. During a big outbreak a considerable part of the population develops either the apparent or the asymptomatic form of this infection. In both cases specific immunity to the causal virus is developed. The fact that a considerable section of the population develops immunity not only leads to the decline of the epidemic, but makes it impossible for it to reappear for several months. The circulation of the virus in question is maintained in the form of sporadic cases among people who have not encountered the infection at the time of the previous epidemic or who have lost their immunity to it, and also in the form of illness among young children who have not met with a given form of influenza.

During the cold season of the year, which is favourable for the spread of this infection, the incidence of a given form of influenza increases; in the warm season of the year, the incidence drops. Since influenza gives only brief immunity, the immune section decreases, with a corresponding increase in the number of susceptibles to a given form of influenza.

Thus conditions develop for another intensive outbreak of influenza, involving a considerable proportion of the population. Outbreaks of influenza caused by one and the same type of the virus are more or less regular, occurring, as a rule, once in two or three years. The fact that several strains of the virus are in simultaneous circulation means that there are outbreaks of influenza practically every year, and sometimes even twice in one year. As a result, the periodicity of these epidemics is not as regular as is the case with some other droplet infections (measles, whooping cough, scarlet fever).

As a rule, an influenza epidemic affects the population of several countries, and at times the infection develops

into a pandemic. The three recent pandemics of influenza—1889-90, 1918-19 and 1957—were particularly intensive. Of these, the pandemic of 1918-19 was clearly associated with World War One and the mortality was signally high. L. V. Gromashevsky considers that trench warfare and the prolonged blockade of a number of countries led to a decline in immunity to influenza. The worsening of living conditions and specifically of nutrition was responsible for the serious nature of influenza cases and the high mortality rate. In just over two years, this influenza pandemic, which at the time was called Spanish 'flu, involved approximately 1,500 million people and took as many as 20 million lives—a heavier toll than was taken by World War One.

Another pandemic of influenza broke out in 1957. Starting in China and in South-East Asia (this was why it was called Asiatic 'flu), the pandemic spread throughout the world within six months, causing over one thousand million cases altogether. With the exception of the Philippines and certain areas in India, where the infection took a severe course, mortality was rather low in most countries. The infection was imported into the U.S.S.R. in April and considerable outbreaks occurred in May, mainly in the Central Asian Soviet Republics (importation from Sinkiang) and along the Trans-Siberian Railway line (importation from North China). In the summer, the upward curve flattened out, notwithstanding the intensive importation of influenza during the VI World Youth and Students' Festival held in Moscow. The bulk of the cases occurred in October and the pandemic ended by late November (Fig. 44). There is no doubt that rigorous medical and prophylactic measures combined with early medical assistance were responsible for the low mortality fig-

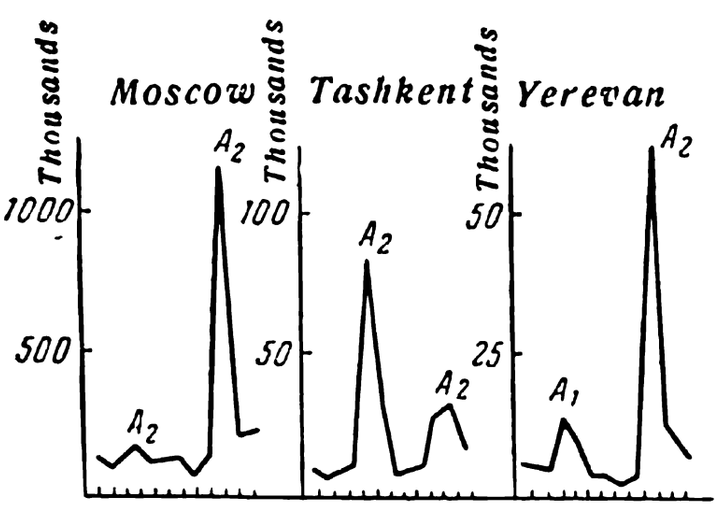


Fig. 44. Three types of pandemic waves of influenza in 1957 (absolute figures of morbidity)

ures in the U.S.S.R. as compared with the capitalist countries mentioned above.

Laboratory Diagnosis. Clinical diagnosis of influenza is difficult, since it is hard to differentiate between this disease and acute catarrhs of the respiratory tract, both of them having similar symptoms. Therefore, laboratory methods of diagnosis have to be employed. The most reliable is the serological method, based on the investigation of the patients' serum taken at the onset of the disease and after another 10-15 days. The growth of the antibodies which inhibit hemagglutination, and also the increase of complement-fixing and neutralising antibodies makes it possible not only to establish the diagnosis of influenza, but also to determine the virus responsible. Unfortunately this method is only a retrospective one. A more promising method of early diagnosis is based on the detection of the influenza virus antigen (hemagglutinin) in washings from the nasopharynx. This method, however, needs to be perfected, since it is insufficiently sensitive and lacks specificity. The most reliable method of influenza diagnosis is the isolation of the virus in chick embryos and in tissue cultures.

Influenza and Influenza-like Diseases. As has been stated, acute catarrhs of the respiratory tract are a combined group of infections with differing etiology.

Table 5

Influenza and Similar Infections

1. Influenza: A, B, C, D
2. Diseases caused by para-influenza viruses: D, HA1, HA2, CA
3. Adenovirus infections: 1-19
4. Common cold
5. Diseases caused by intestinal viruses:
   a) ECHO: 1-24;
   b) Coxsackie: 1-24
6. Diseases caused by viruses CCA, JH and others
7. Atypical pneumonias:
   a) Q-fever
   b) Psittacosis and ornithosis
   c) Eaton's agent (primary atypical pneumonia)
8. Diseases caused by bacteria: staphylococcus, streptococcus, pneumococcus and others
9. Diseases caused by physical factors: cold, dust, irritating gases

To date the following nosological categories have been distinguished:

1. The diseases caused by the para-influenza viruses. Certain biological properties of these viruses are similar to those of influenza viruses. In particular, hemagglutinins are detected in the tissue cultures of the viruses (the hem-adsorption reaction). Three para-influenza viruses are known (they are conventionally called HA1, HA2 and CA viruses); as a rule the influenza D virus is also included in this group. The diseases caused by the para-influenza viruses differ only slightly from influenza proper in clinical symptoms and are differentiated by serological or virological investigation only.

2. Adenoviral infections. The agents are adenoviruses which have been so named due to their frequent isolation from the tonsils and adenoids of healthy people. Nineteen serological types of adenoviruses are known with a common complement-fixing antigen but without cross-immunity in neutralisation reactions. The adenoviruses cause influenza-like infections with a disturbance of the conjunctiva (pharyngo-conjunctival fever), kerato-conjunctivitis, bronchites and at times atypical pneumonias. It is most common in children and young people. Cases occur sporadically or in the form of outbreaks. The most frequent agents are types 1, 3, 5, 7 of the adenoviruses.

3. The common cold is caused by a specific virus or by a group of viruses and is characterised mainly by rhinitis with more or less expressed general symptoms. It occurs in the form of sporadic or group cases and small outbreaks.

4. Certain types of the ECHO and Coxsackie viruses (see poliomyelitis) can cause influenza-like infections. The latter are spread by the droplet and the intestinal-oral mechanisms of transmission.

5. Influenza-like diseases caused by insufficiently studied viruses. These include the recently isolated viruses CCA, the virus of the chimpanzee cold, the rheo-viruses, etc.

The diagnosis of para-influenza and adenoviral infections, of common cold and influenza-like infections caused by other viruses is established by isolating the viruses

in tissue cultures and by ascertaining the antibody titre rise in serological reactions.

6. Atypical viral pneumonias are caused by the viruses of ornithosis and several insufficiently studied viruses, as well as by the Q-fever rickettsiae. In mild cases the diseases are hardly distinguishable from influenza.

7. Bacterial acute catarrhs of the respiratory tract are caused by staphylococci, streptococci, pneumococci and other conditionally pathogenic bacteria inhabiting the upper respiratory tract of man. Cold and dust are important in the pathogenesis of these infections. The general and local effect of a cold weakens the defences of an organism and particularly its resistance in the upper respiratory tract. This explains the activation of the conditionally pathogenic flora and the development of inflammatory processes. Hence bacterial catarrhs of the respiratory tract are observed mainly in the autumn and spring seasons when the effects of colds are particularly noticeable. It is also probable that their appearance is facilitated by dust in the air which causes irritation of the respiratory tract, a possible explanation of the high incidence of these infections in certain occupational groups. However, bacterial infections of the respiratory tract, particularly staphylococcal, are found in children even without the influence of these factors.

Prophylaxis. Prophylaxis and control of influenza are difficult owing to the high infectivity of patients, the rapid spread and mass nature of the infection, and also the difficulty of early diagnosis and differentiation from acute catarrhs of the respiratory tract.

For these reasons it is advisable to carry out anti-epidemic measures simultaneously against influenza and acute catarrhs of the respiratory tract.

An influenza patient should be isolated at home. In view of the great infectivity of influenza patients even this imperfect measure should not be neglected. Moreover, the patient should be isolated in every possible way from those in contact with him by placing a screen around his bed, by removing him to a separate room and by providing crockery, towels and other objects for his sole personal use. The utensils used by the patient must be decontaminat-

ed by boiling or washing in a 0.5 per cent chloride of lime solution; the room must be aired and the floors washed with a chloramide solution. The patient should be placed in a hospital if the disease takes a severe course and there is a danger of complications.

Provision for early detection and isolation of patients should be made at hostels and children's institutions, especially in influenza seasons, and isolation wards should be organised to receive them. Observations indicate that the early detection and isolation of patients in nurseries and kindergartens is an important measure in preventing an outbreak of influenza.

During influenza epidemics arrangements have to be made for domiciliary medical services, so that there should not be overcrowding at polyclinics and outpatients' clinics. This measure is particularly important at children's consultation centres and children's polyclinics in order to prevent these institutions from becoming influenza foci.

During influenza epidemics the medical staff at maternity homes, children's consulation centres and polyclinics should use four-layer gauze masks to avoid contracting influenza and disseminating this infection.

A. A. Smorodintsev's specific anti-influenza serum has been used successfully for treatment and prophylaxis.

The serum is manufactured in the form of a powder mixed with sulphonamide preparations and is administered intranasally to the respiratory tracts by means of a powder blower or by inhalation; when given in liquid form, it is pulverised into the respiratory tract. As a means of prophylaxis the serum is used to suppress outbreaks of influenza and prevent the infection of persons who associate with patients. During an influenza epidemic serum prophylaxis should be carried out in children's institutions, hostels and in families with influenza cases. Therapeutically the serum may be given intramuscularly in severe toxic cases of influenza or when influenza pneumonia develops.

Anti-influenza inoculation is a highly important prophylactic measure. As a result of many years of research, Soviet scientists A. A. Smorodintsev, V. M. Zhdanov, M. I. Sokolov, V. D. Solovyov and their collaborators developed a live anti-influenza vaccine. The vaccine is prepared from

attenuated strains of influenza virus, by the accumulation of the viruses in tissues of chick embryos with subsequent vacuum-drying. The vaccine is given in a double inoculation of 0.5-1 ml of mixed vaccine of A and B viruses in the form of a diluted preparation pulverised in the nasal tract with an interval of two or three weeks between inoculations. Extensive epidemiological observations have shown that the influenza incidence among those inoculated is 50 or 25 per cent of the incidence among people who have not been given the vaccine. Immunity lasts for about one year.

Anti-influenza inoculation should be carried out annually in September-November. It should be given first of all to medical workers, industrial workers, students and senior school pupils. Methods of immunising young children, in whom ordinary live vaccines cause a heightened reaction, are being developed.

In addition to inoculation, measures of hygiene at factories and plants should also be taken as a means of prophylaxis. These should be directed towards the elimination of dust and factors liable to cause chills (see above). The correct physical training in schools and the wide development of sport are also important in increasing resistance. Correct nutrition should be a matter of constant care at children's institutions with an eye to a sufficient amount of vitamins in the daily rations.

The above-mentioned measures should be carried out each year in a planned fashion. Medical institutions should plan prophylactic and anti-epidemic measures to combat influenza.

MEASLES

Etiology. The causative agent of measles is a filtrable virus passed through monkeys and puppies. It grows in human and monkey tissue cultures and causes cytopathogenic changes. The virus of measles is one of the least stable of all-known viruses; it perishes in the external environment within 30 minutes and is conserved by vaccum desiccation or by being stored at —70°C.

Pathogenesis. The portal of entry is the upper respiratory tract. The virus penetrates through the mucous membranes of the respiratory tract to the blood and multiplies in the tissues of the respiratory tract and in other epithelial tissues, causing virusemia, fever, inflammation of the respiratory tract and rash.

The incubation period usually lasts 12 or 14 days, but it may take up to 21 days, and if seroprophylaxis is carried out it can even reach a maximum of 28 days.

Measles infection leads to a radical weakening of the defences of the organism, as in influenza, and can cause the aggravation of latent infections (tuberculosis, dysentery, etc.). This is also why mixed infections in measles (measles and scarlet fever, for instance) take a very grave course and why measles is often accompanied by complications, the result of the activation of the conditionally pathogenic flora (pneumonias, otites).

Sources of Infection. The virus is discharged into the environment with mucosal secretions of the upper respiratory tract. The organism is completely free of the virus by the end of the disease and the infectious period, having begun with the first symptoms of the disease, ends two or three

days before clinical symptoms disappear. Susceptibility to measles is practically universal, the disease always has a clinically manifested form, either severe or mitigated, when a number of pathognomonic symptoms are absent. The infection is accompanied by the development of life-long immunity. Thus, the sole source of infection in measles are patients. No forms of carrier-state have been observed.

Routes of Transmission. Measles is contracted exclusively by the droplet method and the patient is extremely contagious to those who surround him. Even the slightest contact, such as a brief presence in the sick room, usually results in infection for those who have not had the disease earlier.

Epidemiology. Measles, like some other droplet infections, is an infectious disease of childhood, since measles occurs almost exclusively in children, mainly in very young ones (from one to two years). Like other infectious diseases of childhood, this is not due to any physiological peculiarities of a child's organism. The reason is that susceptibility to measles is practically universal, that patients are extremely contagious, and the infectious agent is easily transmitted in present-day conditions of life. Furthermore, because of association among people almost every person contracts measles in early childhood. The life-long post-infection immunity excludes subsequent reinfection.

This is borne out by epidemiological observations of the development of measles epidemics in remote or isolated localities (northern minorities, islanders). In this respect the records of measles epidemics on the Faroe Islands, which had no contact with the mainland, are of particular significance. In 1846 a measles epidemic affected the entire population of the islands, involving all age groups, very old people included, with the exception of those who had contracted the infection at the time of the previous epidemic in 1781. The next importation of measles into the Faroes occurred in 1862 and again the epidemic involved children and adults, excluding only those who had suffered from it during previous epidemics. A similar epidemic broke out in 1875, but this time it was confined to children, since the older people had had the infection at the time of the two previous epidemics.

Cases of measles may be observed throughout the year, with seasonal rises in the autumn and winter and a decline in the summer (Fig. 45). The main cause of the seasonal variation is the change in the children's mode of life. In the cold months of the year children spend more time indoors, which makes for intensive association among them and results in a higher rate of contraction; in the warm months of the year, the opposite is the case. Furthermore, when the air is dry and there is intensive insolation (the summer season) the virus dies off much more rapidly than in winter. This, however, is a factor of less importance than the living conditions of people, as was proved by the epidemic of measles in the Donbas in 1945. During the German occupation the child population in the Donbas was very much smaller than usual, since many children had been evacuated to the Central Asian Republics, the birth-rate decreased and infant mortality increased sharply. When the Donbas was liberated from German occupation a large number of families with children returned to their homes and in summer a considerable epidemic of measles broke out.

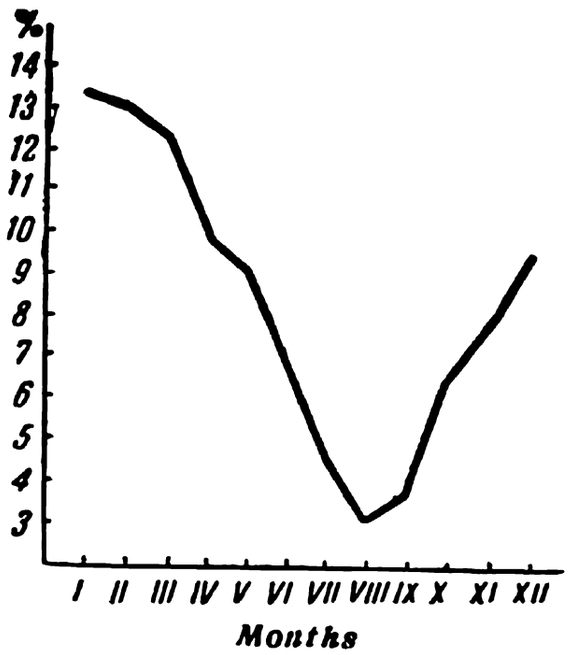


Fig. 45. Seasonal distribution of measles morbidity in the U.S.S.R. (percentages to annual total)

There is a periodic rise in measles morbidity once every three or four years and this is followed by a relatively low level of incidence with the usual seasonal variation (Fig. 46). The periodicity of measles epidemics is associated with the natural growth of the non-immune section of the child population. When it becomes considerable, conditions appear for the development of the epidemic. During the epidemic the greater part of the susceptibles contract the disease. The incidence drops radically in subsequent years, acquiring the pattern of sporadic interrelated cases. In three or four years the number of susceptibles again reaches

danger point, and another epidemic breaks out, etc. Obviously the frequency and intensity of epidemics vary with living conditions and other social aspects of life in a given area.

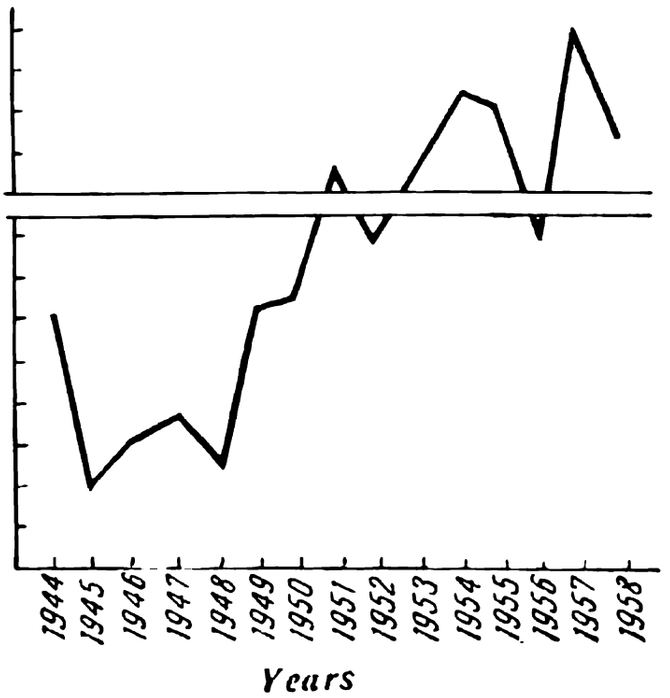


Fig. 46. Periodicity of measles morbidity in the U.S.S.R.

Laboratory Diagnosis. Laboratory diagnosis of measles has become possible by the isolation of the virus from nasopharyngeal washings or from blood, and by ascertaining the virus-neutralising antibody increase. However, as a rule, these methods are not used unless there are special reasons for doing so, because they are complicated, costly and unnecessary, the clinical diagnosis of measles being as a rule rather simple.

Prophylaxis. The existing means of measles prophylaxis are of a palliative character, since a considerable reduction of measles incidence will be achieved only when an effective vaccine is available. Attempts to develop such a vaccine have been numerous and a number of vaccines are undergoing epidemiological tests. There is every reason to expect that this problem will be solved soon.

Meanwhile the main objectives in measles control are to reduce mortality and suppress outbreaks among children under three years of age, a time when this infection is particularly dangerous—that is, to confine measles to older people and to milder forms. These aims are achieved by passive immunisation and anti-epidemic measures. Normal adult serum, commonly called anti-measles serum, since adult serum always has antibodies to the measles virus, is used as a means of passive immunisation. The serum is given to children under three years who have not had measles, whenever there has been association with a measles patient in a family or children's institution. The serum is given

intramuscularly in a dose of 30 ml and the dose is doubled if the child has a weak organism or if more than five days have passed since the contact. When donor serum is not available, parent serum or that of measles convalescents can be used. In the latter case the dose is reduced to 15-20 ml. Today native donor serum is to a considerable extent being replaced by gamma globulin—a serum fraction containing measles antibodies. Gamma globulin is prepared from donor sera, but more often from placental blood, since it is more easily available and costs less. It also rules out serum hepatitis (see "Infective Hepatitis"). Gamma globulin is given in a dose of three to five ml intramuscularly or subcutaneously. When applied in the first three days of incubation, these measures prevent the development of measles; when given in the period from the fourth to the seventh days, the infection is mitigated but lasting immunity is nevertheless developed. Immunisation carried out later attenuates the course of the disease and reduces the possibility of complications.

A measles patient may remain at home. Hospitalisation takes place for clinical reasons (if the disease takes a severe course) or epidemiological reasons (bad housing, small children in the family). The district sanitary-epidemiological station is notified of each case immediately. The isolation of the patient may be ended four days after the rash appears. In children's institutions measles contacts are segregated from the eighth to 14th day after contact; if sera prophylaxis has been carried out, isolation should continue up to the 21st day. Admission of new children to the institution should be suspended for the period in question, and whenever possible children should remain on the premises day and night. Since the virus has poor resistance to environmental influences, disinfection may be restricted to airing and the wiping of objects and walls with a humid cloth. This is done after the isolation of the patient.

WHOOPING COUGH

Etiology. The pathogenic agent of whooping cough is a hemophilic bacillus —*Haemophilus pertussis*. Besides, several other diseases, which take a practically indistinguishable clinical course, are caused by a para-whooping cough bacillus *Haemophilus parapertussis*. The bacillus of whooping cough, like the measles virus, has poor resistance in the external environment.

Pathogenesis. Upon entering the upper respiratory tract, the pathogen settles mainly in the upper and middle sections (trachea, bronchi, bronchioles), where it multiplies and causes local inflammation and resorptive intoxication affecting the vegetative nervous system. The latter aspect is related to the characteristic syndrome of whooping cough —spasms of the small bronchi and paroxysmal coughing. In severe cases the lungs may be affected, usually the result of activation of the conditionally pathogenic microflora of the upper respiratory tract. Since *H. pertussis* is a pneumotropic microbe, it does not migrate beyond the respiratory organs. The incubation period lasts five or seven days, sometimes up to 12 days. The catarrhal stage, the spasmodic paroxysmal stage and the convalescent stage are distinguished in the disease.

Sources of Infection. The patient is most contagious in the first stage and at the beginning of the second stage of the disease. The organism is gradually freed from the pathogen, the process being completed before clinical recovery. Therefore the infectious period lasts 20 or 25 days, including 12 or 15 days from the onset of paroxysmal coughing. There is no carrying of the agent in whooping cough during the convalescent stage.

Whooping cough may have a clinically manifested form and also inapparent forms in which the main pathognomonic symptom—paroxysmal coughing—is absent or very mild. There are grounds for believing that asymptomatic or subclinical forms of the whooping cough infection also exist. Thus, the sources of infection in whooping cough are patients and persons who develop a subclinical form of the infection.

Susceptibility to whooping cough is not universal and is weaker among higher age groups. This is mainly due to the fact that a considerable stratum of the population was infected in earlier years and developed life-long immunity. (The higher the age group the bigger the immune stratum.) However, as distinct from measles, the decrease in susceptibility to whooping cough with age is not only the result of acquired specific immunity but also of physiological distinctions in older children, in whom susceptibility to whooping cough is low or altogether absent. The cumulative effect of these factors is that children over 12 and adults hardly ever have whooping cough, though they may have an asymptomatic form of the infection and be healthy carriers for a short period.

Routes of Transmission. Whooping cough is mainly transmitted by the droplet method. Toys and dishes infected by whooping cough patients may also be of certain epidemiological significance. A whooping cough patient is less contagious than a measles patient, particularly when paroxysmal cough is absent. The explanation is that the *H. pertussis* is localised in the deep sections of the respiratory tract and is discharged in large numbers only during the coughing spasm. Therefore, contraction occurs not in the course of brief contact, but in a more or less prolonged association with the patient—in a family, in children's institutions, etc. The comparatively long period of communicability and the low contagiousness of whooping cough patients explain why outbreaks of whooping cough are not of an intensive nature but rather take a protracted course in the form of individual or group cases.

Epidemiology. The epidemiology of whooping cough is similar to the epidemiology of measles. It has seasonal variations with a peak at the cold period of the year, usual-

ly in the spring, owing to the slow development of whooping cough epidemics (Fig. 47). Once in three or five years bigger epidemics of whooping cough take place and are followed by a period of low morbidity. Incidence among the urban population is higher than in the countryside, where a certain part of the population reaches the age of low susceptibility to whooping cough without meeting the infection.

Laboratory Diagnosis. Laboratory diagnosis of whooping cough is established by isolating *H. pertussis* in nutritive media. Since the pathogen of whooping cough settles in the deep sections of the respiratory tract, the best results are obtained by using the cough-plate method. For this purpose a Petri dish with the nutritive medium is placed not farther than 50 cm in front of the coughing patient. Laboratory investigation of the contents is then carried out.

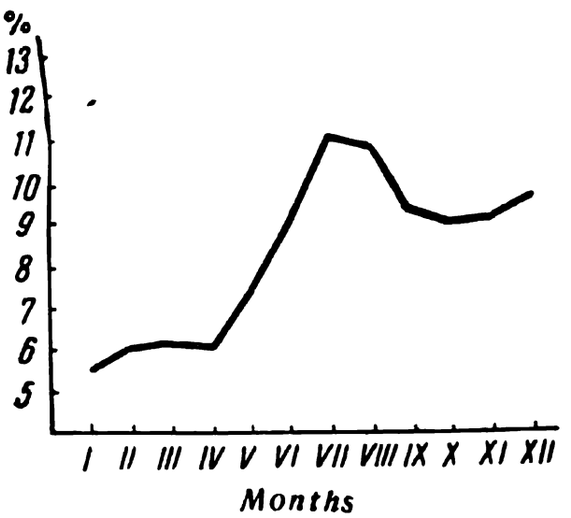


Fig. 47. Seasonal distribution of whooping cough morbidity in the U.S.S.R. (percentages to annual total)

Prophylaxis. Prophylaxis of whooping cough is based on active immunisation and anti-epidemic measures. The whooping cough vaccine consists of killed pathogenic organisms and is used alone or in a mixture with the diphtherial anatoxin. When used alone, the vaccine dose is 1 ml given three times subcutaneously at monthly intervals. Primary immunisation is carried out at the age of five or six months, and reimmunisation, at the ages of one and a half and three or four years, the vaccine being given singly in a dose of 1 ml. Combined diphtheria-whooping cough vaccine is given in the same doses and at the same intervals as the diphtherial anatoxin; children over five years of age are not reinoculated. It should be borne in mind that whooping cough and the diphtheria-whooping cough vaccines cause increased reactions (general and local). Great care must therefore be taken to ensure that if there are contra-indications, inoculation is not done.

Whooping cough patients may remain at home, hospitalisation being carried out when there are clinical or epidemiological reasons for it. The district sanitary-epidemiological station is notified of every case of whooping cough immediately. However, as in measles, the more patients are hospitalised, the better. Segregation for 15 days from the appearance of paroxysmal coughing is carried out in the focus where a whooping cough patient has been detected. During this period efforts must be made to ensure accurate and early detection of other whooping cough patients while they are in the catarrhal stage of the disease. Convalescents may return to their groups as soon as the spasmodic paroxysmal stage is over. When there is a group of convalescents, a special regimen should be organised for them since they are weak and vulnerable to other infections.

Whooping cough foci are not disinfected, it being sufficient to air the premises and wipe the objects with a damp cloth, which should also be done when the sick child remains at home.

DIPHTHERIA

Etiology. The pathogenic agent of diphtheria is *Corynebacterium diphtheriae.* Diphtherial bacilli are relatively stable microbes: they remain viable in the patient's excreta for five or ten days, and in milk and other foodstuffs for 10 or 15 days. Heating to 60°C destroys them in 30 minutes; the same result is achieved by standard disinfectants in a few minutes. Three varieties of diphtherial bacilli are distinguished as regards toxin-formation and virulence, (gravis, mitis and intermedius), which differ also by the biochemical features and the culture media of the colonies. There is evidence that these varieties are mutually convertible and are different stages in the variability of diphtherial bacilli. In addition, there are serological varieties of diphtherial bacilli which are distinguished by the structure of the antigens in the microbial cell. The differences in these bacilli do not affect the properties of the toxin, whose antigenic structure is identical in all serological and other varieties of diphtherial bacilli.

Pathogenesis. The portal of entry is usually the upper respiratory tract, the pathogen settling in the nasopharynx and on the tonsils. After implantation in the tissues it multiplies there, causing necrosis and diphtherial inflammation with the formation of fibrinous film. Though diphtherial bacilli have been recovered from blood, their multiplication does not as a rule spread beyond the pharynx and the upper section of the trachea. Particularly important in the pathogenesis of diphtheria is the local and the resorptive action of the exotoxin produced by the microbes, which mainly affects the kidneys, the adrenal glands, the heart muscle and the nerve tissues. Besides the pharynx, the conjunc-

tiva (diphtheria of the eyes), the genitals and wound surfaces may be the site of implantation and multiplication of diphtheria bacilli, in which case the clinical picture is a combination of local lesions and general intoxication. The incubation period is from two to seven days. The discharge of the pathogen from the organism ceases after clinical recuperation and in some cases the convalescent carrier state continues for months and years.

The clinical course of diphtheria may vary in severity and in the nature of its general and local manifestations. Besides the clinically manifested forms there are subclinical forms and asymptomatic infections which, from the epidemiological point of view, may be identified with healthy carrying. This variety of clinical manifestation is governed by differences in susceptibility and immunity to diphtheria. Natural susceptibility to this infection is far from universal. It is considered that only 20 per cent of those who come in contact with the infection develop the disease, whereas the remaining 80 per cent have the asymptomatic form or infection which does not lead to the development of the disease. Post-infectional immunity is well-pronounced and lasting, which explains the rarity of re-infection. However, immunity is mainly of an antitoxic nature; it prevents the development of intoxication since the blood serum and tissue fluids neutralise the diphtherial toxin, but does not preclude the multiplication of bacteria on the surface areas of the mucosa. Not only persons with primary infection but also those who are immune (because of previous infection or active immunisation) can therefore become healthy carriers and in some cases continue to be so for a very long time. It has been found that the carrying state (convalescent and healthy) more often occurs in persons with chronic afflictions of the pharynx, the nose and nasopharynx (hypertrophy of the tonsils, chronic rhinitis, etc.).

Sources of Infection. Sources of infection in diphtheria may be patients, convalescent carriers (acute and chronic) and healthy carriers (with primary infection or immunity). All three (to be more exact--all five) categories of carriers of the diphtherial bacilli are of epidemiological importance. However, their role also depends on whether the person

in question is a carrier of toxigenous or non-toxigenous diphtherial bacilli.

Routes of Transmission. The main mechanism of transmission is the droplet method. However, owing to the microbe's viability in environment, objects contaminated by the excreta of patients and carriers are also instrumental in spreading this infection, particularly children's toys, crockery, towels, and in some cases urinals and chamber-pots, sponges, etc. (diphtheria of the external genitals in girls). The air-borne dust route of transmission of the infectious agent is also possible in diphtheria, though the importance of this mechanism is negligible.

Epidemiology. Diphtheria is mainly a disease of children under 12 and it is rather rare in higher age groups (though more frequent than measles or whooping cough). The reason is that by this age most of the children have been in contact with the infection many times and have acquired specific immunity even if they have not been inoculated. This process is more intensive in urban conditions than in the countryside, where contact among children is less intensive and the epidemic process not so vigorous. That is why older persons in remote localities may prove to be non-immune and even adults may develop diphtheria (diphtheria in army recruits). The considerable variation in the toxigenicity and virulence of the circulating strains of diphtherial bacilli and the existence of serological varieties, the difference in susceptibility to diphtheria and the variety of clinical forms and intensity of the infectious process, all make it clear why the epidemic process in diphtheria is very complicated and why the immunity pattern varies even within one age group.

Diphtheria morbidity has a seasonal nature similar to that in other infectious diseases of children (Fig. 48). There is no doubt that the beginning of the new school year, with children congregating together more indoors, is one of the main causes of the diphtheria incidence rise in the cold season of the year. Unlike other infections of children, the periodicity of diphtheria epidemics is vague and this is also due to the complexity of the epidemic process, in which the exhaustion of the susceptible groups of population is gradual.

In Russia before the Revolution diphtheria was one of the gravest infections of children, causing high morbidity and mortality. The introduction of specific serotherapy brought about a decrease in the mortality rate but not as big as in other European countries because the shortage of doctors meant that a considerable part of the population, particularly in rural localities, did not get timely serotherapy. The reduction of diphtheria morbidity became possible in the twenties with mass manufacture of the diphtherial anatoxin by Ramon's method. Since then diphtheria morbidity and mortality in the U.S.S.R. have been on the decline, although there were a few rises in certain years (in the late thirties, late forties and early fifties). In many towns diphtheria occurs only in the form of sporadic cases or has been eradicated altogether (Leningrad, Rostov-on-Don). This is equally true of rural areas. The current anti-diphtheria plans provide for further reduction of diphtheria morbidity to isolated cases throughout the country and its eventual total suppression.

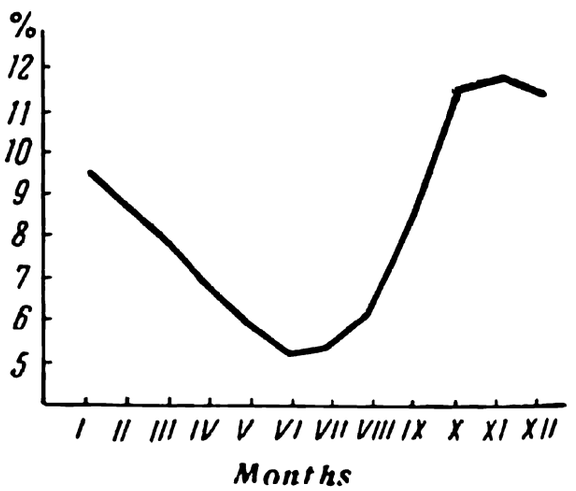


Fig. 48. Seasonal distribution of diphtheria morbidity in the U.S.S.R. (percentages to annual total)

Laboratory Diagnosis. Laboratory diagnosis of diphtheria is simple. It is done by means of bacterioscopy of smears from the larynx and nose and the planting of these materials on nutritive media (coagulated serum). A preliminary result may be obtained on the day the material is drawn (bacterioscopically), and the final result, on the second day. When the toxigenicity of diphtherial cultures has to be determined, additional investigations are required.

Prophylaxis. Prophylaxis of diphtheria is based on regular active immunisation of children with diphtherial anatoxin, the detection and sanation of carriers, and also on anti-epidemic measures in diphtheria foci. The fight against lethality is based on early diagnosis and specific treatment with serotherapy, antibiotics, etc.

Inoculation is the basic measure in diphtheria prevention. The diphtheria toxoid suggested by Ramon in 1920 is used in vaccination to this day, although the method of manufacture has been modified considerably since then and two types of the preparation are produced: diphtheria toxoid, purified and absorbed on aluminium alum, and the combined diphtheria-whooping cough vaccine. The two preparations are given in similar doses and are administered intramuscularly. In primary immunisation three injections are given at monthly intervals. Reinoculation is done with single doses. Children are first inoculated at the age of five or six months, and inoculated at the age of one and a half, and three or four years; all with the combined diphtheria-whooping cough vaccine. Two more reinoculations are carried out at the age of seven or eight and 10 to 12 years and, if there are epidemiological reasons, at 16 or 17; these are done with the diphtheria toxoid only. It should be borne in mind that since the diphtheria-whooping cough vaccine can cause allergic reactions, children should be examined carefully, and where there are contra-indications they should not be immunised. At the same time an effort should be made to immunise as many children of the appropriate age as possible since the existence of even a small group of those not inoculated creates a potential for a rise in diphtheria morbidity.

Experience in several European countries has shown that when the anti-diphtheria inoculation programme is well organised this disease can easily be eradicated in a few years. The same has been proved by experience in many towns and areas of the Soviet Union (Fig. 49).

This is why public health bodies have been given the task of eradicating diphtheria within a few years throughout the U.S.S.R.

An important measure in diphtheria prophylaxis is control of the carriers. With this in view, examinations for diphtheria carriers are arranged annually among staffs of maternity homes and pre-school children's institutions. Furthermore, diphtheria patients are discharged from hospitals only after screening by bacteriological investigation. Carriers are not admitted to children's institutions and are subject to sanation by means of antibiotics. In these

cases it is advisable to determine the toxigenicity of the diphtherial bacilli isolated from them, and to apply restrictive measures only to carriers of toxicogenic diphtherial bacilli. The period of segregation should not exceed 30 days provided all contacts have been adequately immunised.

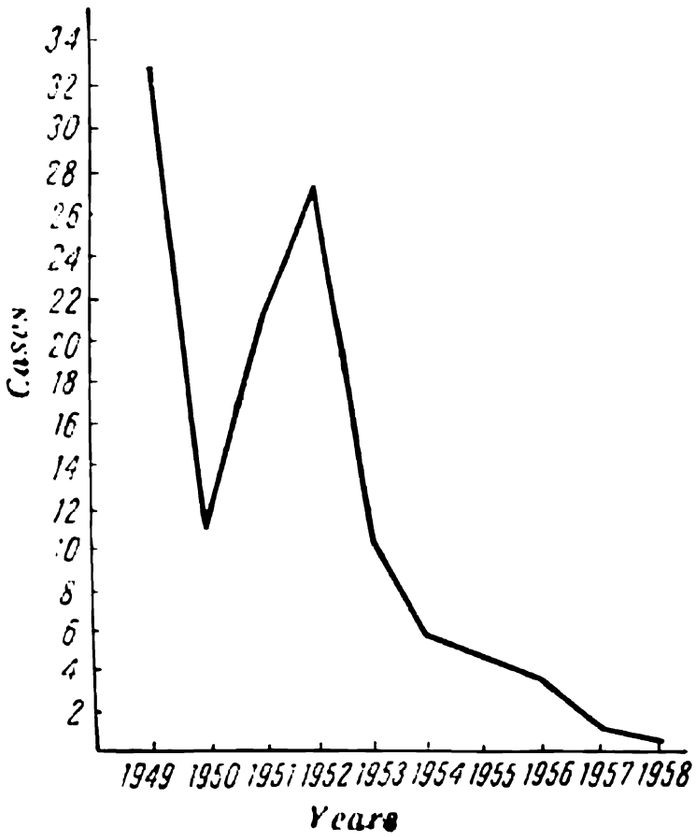


Fig. 49. Eradication of diphtheria in Leningrad

A diphtheria patient must be placed in a hospital for infectious diseases. Every case of diphtheria has to be reported to the district sanitary-epidemiological station. Anti-diphtherial serum is administered on the spot without waiting for final diagnosis and hospitalisation. To exclude the possibility of anaphylactic shock the serum is administered in two portions by Bezredke's method: first 0.1-0.3 ml and the remainder after two hours. Linen is disinfected by boiling, clothing by chamber disinfection and floors and household objects in the focus are washed. Children under 12 are segregated for seven days and subsequently examined for the carrying of diphtherial bacilli.

SCARLET FEVER

Etiology. Scarlet fever is caused by hemolytic streptococci (*Streptococcus hemolyticus*). Several dozen serological varieties of streptococci with different antigenic structures are known. All of them produce one and the same exotoxin. The viability of streptococci in environment is similar to that of the diphtheria microbe but they perish more readily in desiccation, so that the dust-borne mechanism of transmission found in diphtheria is impossible in scarlet fever. At the same time the streptococci can remain viable for a long time in food products, particularly in milk and in foods containing sugar; milk-borne outbreaks of streptococcal infections (of the toxic food infection type) and of scarlet fever are possible.

Pathogenesis. Scarlet fever is one of the clinical manifestations of streptococcal infections; other manifestations are pyoderma, erysipelas, sepsis and afflictions covered by the general term rheumatic carditis. This variety of clinical manifestations of streptococcal infection is determined by the presence of toxins and corpuscular antigens in the streptococcus, by the complexity of the immunogenesis in streptococcal infection, in the course of which infectious allergy can be set up, and by the portal of entry of the streptococcus. Speaking generally, scarlet fever may be described as a primary encounter with the streptococcus accompanied by the development of an antitoxic immunity, whereas rheumatic carditis is an infection occurring in an organism which has developed antitoxic immunity and has the symptom of an infectious allergy.

An important part in the pathogenesis of scarlet fever is the intoxication caused by the multiplication of streptococci, above all in the pharynx and the nasopharynx, and the arrival of the streptococcal toxin in the organism. The disease develops following an incubation period of three to seven days (its maximum duration is 12 days) and takes the course of a general feverish condition with local involvements of the larynx and the nasopharynx, intoxication and rash. Purulent and septic complications of scarlet fever are caused by the penetration of the streptococci (in many cases owing to reinfection or superinfection) into the blood and their multiplication in internal organs. Scarlet fever may take a clinically manifested or an inapparent form; in the latter many of its pathognomonic symptoms are absent. It was noted long ago that scarlet fever epidemics are accompanied by a rise in the incidence of tonsillitis, which is a frequent manifestation of streptococcal infection. Serological studies show that the primary streptococcal infection can also take an asymptomatic course. The organism gets rid of the pathogen gradually and in a considerable percentage of the patients the process is terminated only after clinical recovery. A certain percentage of patients become convalescent carriers.

When penicillin or other antibiotics are used the streptococci perish rapidly (in two or five days). Antibiotic therapy, however, may alter the normal immunogenesis, with the result that relapses are possible in penicillin-treated patients and there may be reinfection, which was very rare prior to the introduction of antibiotic therapy.

Sources of Infection. The sources of infection in scarlet fever are patients, convalescent carriers and healthy carriers. The latter, as in diphtheria, may be either immune or suffering from primary infection.

Routes of Transmission. The infectious agent in scarlet fever is transmitted by the droplet method, though the factors involved in transmission may include household objects, crockery, toys and food products, milk in particular. Scarlet fever infection is possible also through wound surfaces and the parturient canal (extrabuccal scarlet fever).

Epidemiology. Scarlet fever mainly affects children under

12 years of age but may also occur in adults. The reasonal pattern of scarlet fever is typical of other children's infections. Morbidity increases in early autumn with the beginning of the school year when children congregate together indoors. During the summer, scarlet fever incidence drops. Considerable epidemics occur once in three or five years. However, the periodicity of scarlet fever epidemics is not as regular as in measles (Fig. 50). Scarlet fever morbidity in rural areas is lower than in towns owing to the lower intensity of the epidemic process. As a result, many country-dwellers have no immunity in adolescence, whereas most of the children in big towns encounter scarlet fever infection or acquire immunity by 12 years of age or even earlier, in pre-school or early school years.

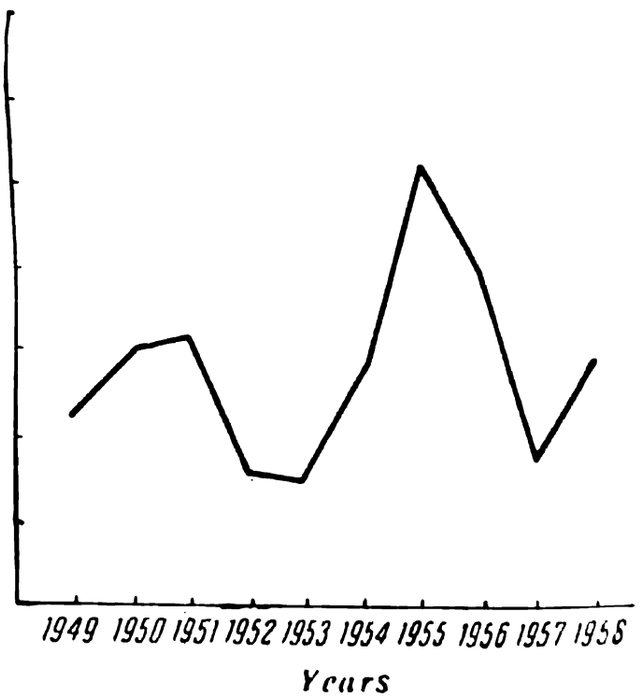


Fig. 50. Periodicity of scarlet fever morbidity in the U.S.S.R.

An obvious evolution of scarlet fever has been taking place during the recent 20 or 30 years, the course of the disease becoming milder, with a sharp drop in mortality. Before it was justly regarded as one of the gravest infections of children with a high mortality rate (eight or twelve per cent) and accompanied by complications, frequently of a stable nature (purulent otitis with the development of deafness, nephritis, lesions of the heart muscles, etc.).

At present, scarlet fever is one of the mildest of children's infections with negligible mortality (0.001 per cent). The introduction of penicillin only in part explains this development, since scarlet fever also takes a mild course in those who have not been treated with penicillin. The phenomenon is more likely the sign of a general weakening of the toxicogenic properties of streptococci, or of the general increase in the resistance of the population to primary streptococcal

infection. A satisfactory explanation has not yet been found for this phenomenon.

Laboratory Diagnosis. Laboratory diagnosis of scarlet fever is possible either by recovery of streptococci from the larynx or by the determination of antibodies to the streptococcus, its toxins and enzymes in the blood serum. This method of diagnosis is not in general use owing to the widespread nature of the streptococcus, which is frequently found in the larynx of healthy people, and also because it is impossible to distinguish the streptococci which have caused the infection in question from the tremendous mass of streptococci circulating among the population.

Prophylaxis. The prophylaxis of scarlet fever has rather limited objectives, the reduction or mortality and occurrence of complications, and the suppression of scarlet fever outbreaks in children's institutions.

So far attempts at developing vaccines for active immunisation have failed. The proposed vaccines made of killed microbial organisms and toxins of the streptococcus and the mixed preparations have produced limited effect and only when a large number of injections (three to five) has been given. An increase in the dose of the antigen led to serious reactions which differed but little from the infection proper, whereas attempts to obtain a harmless preparation of the anatoxin type have failed. Therefore active immunisation in scarlet fever is still a problem to be solved, and the preparations which are manufactured for the purpose (for instance purified adsorbed streptococcal toxin) have only a limited application. Sera prophylaxis of scarlet fever by donor serum and gamma globulin is also of limited application.

The scarlet fever patient may remain at home for treatment or may be hospitalised for the clinical and epidemiological reasons mentioned in the chapter on measles. The district sanitary epidemiological station is informed of cases of scarlet fever immediately. When scarlet fever patients are hospitalised, it is advisable to fill the wards and to discharge the patients simultaneously, since this prevents reinfection with the streptococci circulating in the hospital. Reinfection frequently leads to the development of purulent and septic complications. Adequate ventilation

has to be provided in the wards. Patients should be discharged on the 7th-12th day of the disease if there is clinical recovery, and when penicillin treatment is used they may be sent home even earlier (in four or five days) for the convalescent period. In all these cases children under 12, as well as adults working in pre-school institutions and in the first two forms at school, are allowed to go to work or school after 12 days of isolation at home.

In children's institutions (nurseries, kindergartens, the junior school), where scarlet fever cases have occurred, a seven-day segregation is practised.

There is no final disinfection in the focus, it is sufficient to wash the floors and household objects and to air the room, which should be done throughout the time the patient is there.

EPIDEMIC ENCEPHALITIS

Etiology. Epidemic encephalitis (lethargic encephalitis, type A encephalitis, Economo disease) is an acute infectious disease mainly affecting the brain.

The disease has been known at least since the 18th century, but many aspects of its etiology and epidemiology are still obscure.

In the first place, even the causative agent of epidemic encephalitis has not been discovered. Bacterial origin can be considered to be completely ruled out and practically all investigators agree that the causative agent of epidemic encephalitis is a filtrable virus.

Following the studies made by Levaditi and his collaborators (1920-29) it was for some time thought that the agent of epidemic encephalitis was the herpes virus. This point of view was based on experiments with test rabbits which developed typical symptoms of encephalitis with a fatal outcome (fulminant form of encephalitis) after being infected in the brain or the cornea with suspension from the brain of people who had died from the disease. During subsequent investigations an absolutely similar picture of the disease was produced in rabbits when they were infected with herpes vesicle fluid. Immunological studies showed that the two viruses were identical. On the strength of these data some scientists were led to believe that both infections—epidemic encephalitis and *Herpes simplex*—were caused by one and the same agent, the virus of herpeto-encephalitis (Levaditi). Others (L. V. Gromashevsky) believed that the pathogenic agents of herpes and encephalitis differed, though their immunological and biological properties were very much alike.

As a result of subsequent investigation Levaditi's error was revealed. We have to agree with the conclusions of L. A. Zilber (1945) that Levaditi was dealing not with the true agent of epidemic encephalitis but with *Herpes simplex*, frequently recovered from humans. Infection with the herpetic virus in childhood usually leads to the

development of aphthous stomatitis of short duration. Following recovery from this disease, many people become virus-carriers for a long time, sometimes for life. When the defence mechanism of the organism is weakened due to various causes, including infectious diseases, a herpetic virus can produce an outburst of the infection which manifests itself, as a rule, in the form of a vesicular eruption near the mouth and the nostrils; in rare cases, a graver affliction might develop—encephalitis. Probably when Levaditi investigated patients suffering from epidemic encephalitis, it was not the true agent of this disease that he recovered, but the accompanying virus of *Herpes simplex*, and this had led him and other authors to erroneous conclusions.

Subsequently attempts to isolate the virus of epidemic encephalitis were made by M. P. Chumakov (1942-44) and others, but to no purpose. Thus, the virus of epidemic encephalitis remains undiscovered and its properties may be deduced only by indirect epidemiological data. Epidemiological observations indicate that the agent of encephalitis is of low resistance and perishes quickly in the environment. This explains why contagion occurs only through association with a patient or carrier.

Pathogenesis. Epidemiological surveys and pathologo-anatomical and histological investigations give grounds for supposing that the pathogenic agent of epidemic encephalitis invades the organism through the upper respiratory tract (nasopharynx) and from there penetrates the brain. It is believed that the virus is propagated along the nerves reaching the brain from the nose and the nasopharynx via the endings of n. olfactorii. The nasopharynx, apparently, is also the place where the virus is discharged from the organism.

The clinical course of epidemic encephalitis varies greatly in severity and in the intensity of symptoms. Alongside the clinically manifested forms with a sub-acute or acute course, and the subsequent development of parkinsonism, the disease can take an inapparent form, when the neurological symptoms are weak and only the not very characteristic symptoms of rhinopharyngitis are present. Finally, some infected persons have the asymptomatic form without clinical signs of the disease.

Reinfections do not usually occur and it must be concluded that the infection (apparent, inapparent or asymptomatic form) leads to the development of stable immunity.

Sources of Infection. Man is the sole reservoir of the virus of epidemic encephalitis. Patients with the apparent and inapparent forms of the disease and carriers may be sources

of infection. The duration of the contagious period is unknown. In view of the existence of a sub-acute and at times a chronic recurrent type of the disease, it must be assumed that the virus of encephalitis can survive in the patient's organism for a long time. Cases have been observed of patients infecting persons in contact with them several months or even more than a year after the onset of the disease. Such cases indicate that there are virus-carrying convalescents. In addition to the convalescent carrying state in epidemic encephalitis there is healthy carrying which, viewed pathogenetically, is tantamount to the asymptomatic infection. Thus, in epidemic encephalitis, apart from obvious patients, those suffering from obliterated forms of the disease and carriers are of great epidemiological significance.

Routes of Transmission. Epidemic encephalitis is spread by the droplet method. It can be regarded as proven that household objects are not instrumental in the transmission of this infectious agent.

Discussing the susceptibility of the population to encephalitis, L. V. Gromashevsky and G. M. Weindrach point out that when only one per cent of the people infected develop clinically manifested forms of the disease, the rest have the disease in the abortive and inapparent forms, or become healthy carriers. What is more, people who have had the infection in the past can again become healthy carriers. This is why cases of epidemic encephalitis are as a rule sporadic and apparently unconnected.

Epidemiology. It should be pointed out, however, that although the majority of investigators support this view on the sources of infection and the nature of the epidemic process in epidemic encephalitis it cannot be regarded as unquestionable. There are still many moot points in the epidemiology of encephalitis. The disease is clearly an old one since the residual syndrome of Parkinson's disease characteristic of it was known even before the works of von Economo. The disease attracted attention in connection with the rise in morbidity which began in the first years of World War One and reached its peak in 1918-20, coinciding with a pandemic of influenza. It was suggested that a decline in resistance caused by influenza (it may be recalled that during the pandemic of 1918-20 practically the

entire population of the world contracted influenza) led to an increase in the susceptibility to epidemic encephalitis. However, it is doubtful whether this supposition should be accepted unreservedly, since subsequent big epidemics of influenza have not been accompanied by an increase in encephalitis morbidity. Besides, it is doubtful whether the viewpoint that epidemic encephalitis is a ubiquitous disease is correct. It seems more probable that owing to the low natural susceptibility of a considerable proportion of the population to this disease, this infection is not very widespread.

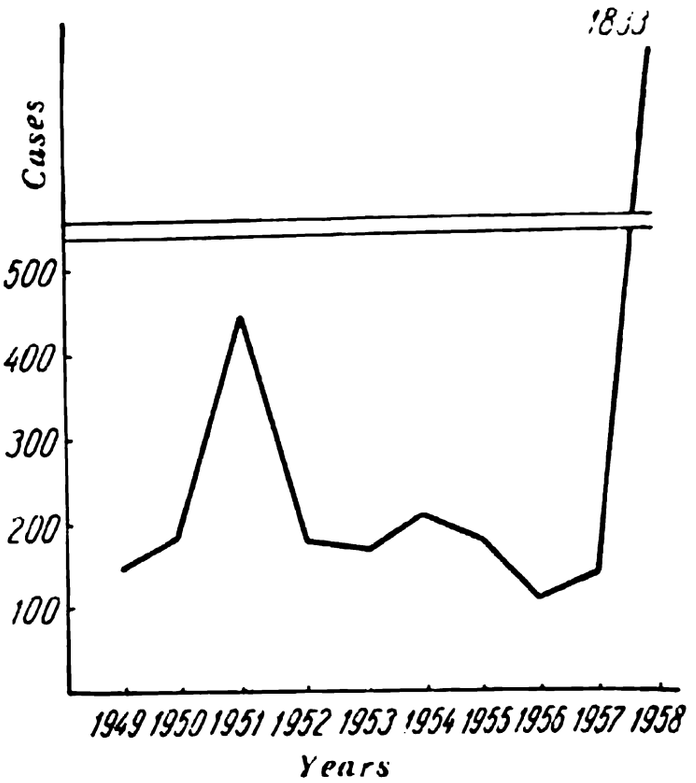


Fig. 51. Economo disease morbidity for 10 years in the U.S.S.R.

Cases of epidemic encephalitis have been described in different countries. They occur sporadically or in the form of minor outbreaks. As a rule, the morbidity indices are only fractions of unit per ten thousand of population. During the previously mentioned epidemic of encephalitis (1919-20) the morbidity indices were seldom more than 2-2.5 per ten thousand of population. Between 1918 and 1920 this disease reached a peak in the U.S.S.R. Subsequently morbidity has been kept at a low level (Fig. 51).

Epidemic encephalitis afflicts mainly adults, another argument against regarding encephalitis as one of the widespread diseases which affect the population already in childhood. The same consideration excludes analogies between epidemic encephalitis and meningococcal meningitis.

The disease is more frequent in towns than in rural areas. Thus, 86.8 per cent of encephalitis cases in Britain are found among town-dwellers and 13.2 per cent, in rural areas. In the U.S.S.R. the urban population accounted for 60.6 per

cent of all cases from 1946 to 1952, and the rural—for 39.4 per cent. The morbidity of epidemic encephalitis has a pronounced seasonal pattern, occurring mainly in the winter months.

Laboratory Diagnosis. There are no methods of laboratory diagnosis of epidemic encephalitis and the diagnosis is made as a result of clinical examination.

Prophylaxis. Since there is no specific prophylaxis against epidemic encephalitis the fight against this infection is based on general anti-epidemic measures.

The patient is subject to compulsory hospitalisation. The district sanitary-epidemiological station is notified immediately. Whenever cases occur in a collective (hostel, children's institution, etc.), active measures should be taken to detect other patients (measurement of temperature, questioning to reveal early symptoms). The length of stay in hospital depends on clinical indications.

The focus should be kept under observation for three or four weeks corresponding to the time of the incubation period. Disinfection of the focus is unnecessary.

EPIDEMIC CEREBROSPINAL MENINGITIS

Etiology. The pathogenic agent of epidemic cerebrospinal meningitis, meningococcus (*Neisseria meningitidis*), is one of the pyogenic cocci and in many of its biological properties is similar to the agent of gonorrhea. Meningococcus is unstable in environment and perishes within a few hours on objects polluted with the excreta of patients; it is poorly resistant to desiccation and is neutralised in a few minutes by disinfectants (phenol, crezol, chloride of lime, etc.) of standard concentration.

Culture of meningococci requires a medium rich in proteins. The white mouse is the most sensitive test animal to meningococci. Four serological variants of meningococcus are known and designated as A, B, C and D. The most common are the A and B variants.

Pathogenesis. The portal of entry is the upper respiratory tract and the pathogen develops on the mucous membranes of the nasopharynx. The multiplication of the meningococcus occurs in the surface layers of the mucosa and is accompanied by a catarrhal inflammation (nasopharyngitis). The meningococci then enter the blood stream causing meningococcemia; the blood stream carries them to the pia mater where they cause acute purulent leptomeningitis. Less often there are involvements of the joints (arthritis), of the heart (endocarditis) and numerous lesions of the serous membranes (polyarthritis).

The pathological process, however, seldom reaches such advanced stages. Often the process is limited to meningococcemia without secondary focal lesions (meningitis), or

even to catarrhal nasopharyngitis without the subsequent spread of the meningococci in the organism. Thus the implantation of the agent and its discharge from the organism with the mucosal secretion takes place through the nasopharynx.

As a rule the meningococcus remains in an infected organism even after the termination of the disease and the recovery of the patient, since the meningococcus can survive and multiply on the mucous membranes of the nasopharynx. When patients are treated with chemodrugs (sulphonamides and penicillin) the organism is free of the meningococcus within a few days.

The clinical manifestations of a meningococcal infection vary with the characteristics of the pathogenesis: there may be acute purulent (less often serous) cerebrospinal leptomeningitis and meningococcal sepsis, catarrhal nasopharyngitis, and finally asymptomatic infection. The asymptomatic infection and the inapparent forms of the disease (nasopharyngitis) are more common than the clinically manifested form, acute purulent meningitis. The disease leads to the development of a lasting immunity and reinfections are rare. Immunity is acquired after clinically manifested, inapparent and asymptomatic forms of the infection.

These peculiarities of the pathogenesis and immunity in epidemic cerebrospinal meningitis are of considerable significance in the epidemiology of this infection.

Sources of Infection. Epidemic cerebrospinal meningitis is a disease only affecting man, and man is the sole reservoir of the pathogenic agent. The sources of infection are patients, convalescent and healthy carriers.

The epidemiological significance of the three categories of infection sources varies.

People suffering from a clinical form of the disease are rarely a source of new infections, whereas contagion is much more frequent in the case of patients suffering from inapparent forms, and carriers. It is difficult to obtain more accurate data on the comparative frequency of clinically manifested and asymptomatic forms of the disease, because of the difficulty of diagnosing the latter cases; when thorough investigation was possible, the number of asympto-

matic cases detected was several times that of meningitis patients.

There are two categories of carriers in epidemic cerebrospinal meningitis: convalescent and healthy carriers. Chronic pathological processes in the nasopharynx make for the development of protracted carrying, as in diphtheria. Convalescent carriers, specifically those with the chronic form of the disease, are an important source of infection.

Healthy carrying is a result of asymptomatic meningococcal infection; it can arise both in the primary and in the secondary infection. Observations have shown that the number of healthy carriers considerably surpasses that of patients (four- or tenfold). As a rule healthy carrying is of short duration and terminates within ten or fourteen days.

Routes of Transmission. The droplet method is practically the only way in which epidemic cerebrospinal meningitis is transmitted. Since the agent readily dies outside man's organism, the only household objects of epidemiological significance are dishes and toys. The bulk of infections result from direct association with patients and carriers.

Human susceptibility to epidemic cerebrospinal meningitis is low. L. V. Gromashevsky and G. M. Weindrach have demonstrated that out of 200 persons infected with the meningococcus only one person develops meningitis, in one or two meningococcemia sets in, in 15 or 16 the symptoms of nasopharyngitis are observed and the remainder have the asymptomatic form of the infection and become healthy carriers.

Epidemiology. The epidemic process in meningitis, therefore, is quite specific; most of the infected people develop the asymptomatic form of the disease and become healthy carriers, some have inapparent forms and only a few develop the clinically manifested form. As the first and second categories of infected persons may be detected only by specific investigation, the disease, even in a big epidemic, acquires the nature of scattered, apparently unconnected cases. Patients suffering from obliterated forms of the disease and carriers which are the connecting links between individual cases, are only detected on thorough clinical observation and bacteriological investigation.

Epidemic cerebrospinal meningitis is a world-wide disease, more prevalent in countries with a temperate climate than in hot countries. As a rule it occurs sporadically, and in the form of small outbreaks, though big epidemics are observed from time to time.

In the U.S.S.R. meningitis occurs sporadically; small outbreaks are rare and involve no more than a few dozen people. The morbidity is non-uniform in different age groups. Epidemic meningitis afflicts mainly the younger children. As for the causes of greater morbidity among children, some people attribute this to the physiological age peculiarities of the organism, owing to which children are more susceptible than adults to many infections. Others believe that the physiological age peculiarities are of no significance, and that the decline in the morbidity rate with age is a result of specific immunity, acquired in previous apparent or asymptomatic infection.

Fig. 52. Seasonal distribution of meningitis morbidity in the U.S.S.R. (percentages to annual total)

In fact both suppositions are valid, though each is but a partial explanation. If we accept the latter point of view we would be saying that every person had contracted meningococcal infection in the apparent or the asymptomatic form in his childhood, which is far from being the case.

Epidemic cerebrospinal meningitis is more frequent in towns where congestion is greater than in the countryside. It is clearly a crowd disease afflicting mostly those who are living in substandard conditions.

The influence of overcrowding upon the morbidity of epidemic meningitis is illustrated by the following example given by Glover. Among British troops living in good hygienic conditions, from two to five per cent of the men were found to be carrying meningococcus and there were no cases of clinical meningitis. Carrying was found in 35 per cent of the men among troops which were living in overcrowded and unfavourable hygienic conditions. Cases of

meningitis were also recorded. Meningitis occurs more often in the cold season of the year (Fig. 52).

The seasonal variation in the morbidity of epidemic meningitis is not as evident as in other droplet infections.

Laboratory Diagnosis. Laboratory diagnosis of meningitis is established by the isolation of meningococci from the mucosa of the nasopharynx or from the spinal fluid; in the case of meningococcal sepsis, from the blood, the punctate of affected joints and other seats of infection in the organism.

Prophylaxis. Prophylaxis and suppression of epidemic cerebrospinal meningitis are based mainly on general anti-epidemic measures.

A meningitis patient should be isolated and placed in an infectious diseases hospital for a period of 21 days. The patient should not be discharged before the results of bacteriological investigation become negative. In every case of epidemic cerebrospinal meningitis the district sanitary epidemiological station is notified.

When a number of cases occur in a children's institution, active measures have to be taken to detect patients suffering from mild and inapparent forms of the disease. Besides clinical observation (nasopharyngitis), it is expedient to institute a bacteriological investigation of the mucus of the nasopharynx of persons who have been in close association with the patient.

Both the patients and the carriers are given chemotherapeutic treatment.

These measures are the whole extent of the work in meningitis foci. Disinfection in the focus is unnecessary and it is sufficient to wipe objects with a moist cloth and air the premises. There are no specific methods of preventing epidemic cerebrospinal meningitis (vaccination, seroprophylaxis) and there is no particular need for them since meningitis is a comparatively rare disease.

CHICKEN POX

Etiology. The pathogenic agent of chicken pox is a filtrable virus. It has little resistance to environmental influences and dies quickly outside the organism of man. The virus is strictly adapted to a parasitic existence in man's organism and can be isolated only from tissue cultures or on human skin inoculated into the chorioallantois of chick embryo.

The agent of *Herpes zoster* closely resembles the virus of chicken pox. The two viruses are indistinguishable in morphology of elementary bodies and inclusion bodies. Available data also point to immunological similarity and even identity of the two viruses. The patho-histological picture of rash elements in *Herpes zoster* and chicken pox is also very similar. The similarity of the two diseases is confirmed by certain epidemiological observations. In view of all this some authors identify chicken pox and herpes zoster and regard the latter as a manifestation of chicken pox in adults. This point of view, however, cannot be regarded as proved beyond doubt. Immunological similarity occurs in pathogens of different diseases (for instance, the pathogenic agents of louse-borne typhus fever and murine typhus, the agents of smallpox and cowpox). From the clinical and epidemiological points of view, herpes zoster and chicken pox are different diseases and there are no grounds for identifying the two diseases.

Pathogenesis. The pathogenesis of chicken pox is similar to the pathogenesis of smallpox. The pathogenic agent invades the organism through the upper respiratory tract,

multiplying at the place of implantation and entering the blood stream. It is carried by the blood stream and settles mainly in the epithelium of the skin and the mucous membranes, causing the development of a characteristic vesicular rash. There are cases of the virus affecting the pia mater (serous meningitis). Thus, owing to its dermotropic nature (adaptation to the epithelial tissue), the virus accumulates mainly in the epithelium of the skin and the mucosa, and sometimes in the pia mater. The virus is discharged into the environment with the content of skin and mucosa vesicles, and this is particularly important for the transmission of the agent from a diseased person to a healthy one. The vesicles found on the mucous membranes of the respiratory tract macerate quickly, their content arrives at the surface of the mucous membrane, which facilitates the transmission of the infection by the droplet method.

Apparently the disease always takes a sufficiently specific clinical form. Following an incubation period of 14-16 days (variation is comparatively rare, ranging from 10 to 23 days), a fever develops, there are moderately general disorders and vesicular rash on the skin and the mucous membranes. At times these symptoms are supplemented by phenomena of meningitis. The grave forms of the disease (pustulous, bullous, hemorrhagic) are rare. The infection leads to the development of a stable immunity.

Sources of Infection. Man is the sole reservoir of the chicken-pox virus. The only source of infection is a chicken-pox patient. The contagious period in chicken pox is brief, the patient is dangerous to those around him from the first days of the disease until the seventh day after the appearance of vesicles. The early developed immunity results in the destruction of the virus in the organism of the patient. The patient is extremely contagious for susceptible contacts, since a tremendous number of virus particles is discharged in the air during talking, coughing and sneezing. The nature of the immunity precludes any form of carrying (convalescent or healthy) in this infection.

Routes of Transmission. The transmission of infection occurs almost solely by the droplet method; transmission with toys used by the sick child is also of some importance,

but since the virus perishes readily in the environment, the importance of the latter method of transmission is very limited.

Susceptibility to chicken pox is universal in childhood. It may be considered as proved that in modern conditions every person contracts this infection in childhood and therefore the non-susceptibility of adults is a result of immunity acquired in childhood.

Epidemiology. Chicken pox is a world-wide infection afflicting practically the entire population; in this respect it may be compared to measles. Owing to the high susceptibility of the population, the great infectiveness of the patient and the droplet method of transmission, almost all children contract the disease, and it seldom occurs in persons over 15 years of age.

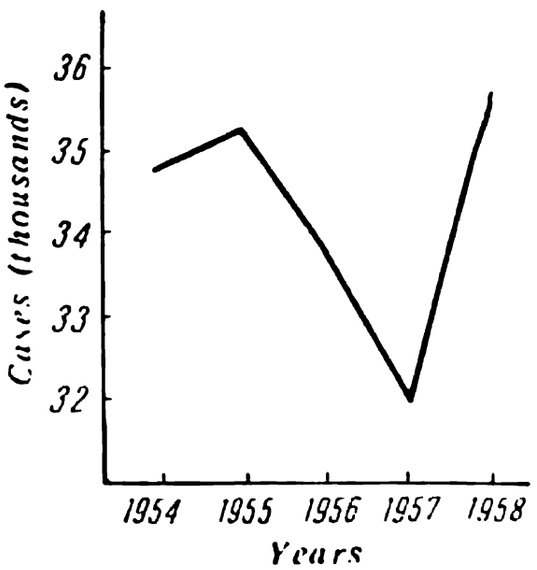


Fig. 53. Chicken pox incidence in Moscow

As in other infections with the droplet mechanism of transmission, morbidity is higher in the cold months of the year. A certain periodicity of chicken-pox epidemics is observed, as with measles (Fig. 53).

There are no full statistics of chicken-pox morbidity because many parents do not apply for medical assistance when their child develops the disease and, therefore, the available data on morbidity are approximate.

Diagnosis. The clinical picture of chicken pox is sufficiently specific and laboratory investigation is not needed. Doubt may arise only in serious cases, when chicken pox has to be distinguished from smallpox. In this case Paul's diagnostic test is made (see "Smallpox") and other types of virological investigation are undertaken.

Prophylaxis. The child suffering from chicken pox is isolated at home: the isolation of the patient ends five days after the appearance of the last fresh element of rash. When chicken-pox cases are detected in a group of children, the

contacts under seven years of age are segregated between the 11th and the 21st day of contact. As a rule this is the extent of anti-epidemic measures in chicken pox.

Seroprophylaxis with adult serum (so-called anti-measles serum) and gamma globulin may be recommended as an additional measure. The preparations are given in the same doses as in seroprophylaxis of measles and are particularly effective in the first four days after infection. Seroprophylaxis is advisable for children who are not very strong and also for the suppression of an outbreak of chicken pox in a nursery or kindergarten.

The suggested method of active immunisation by inoculation with the vesicle fluid has not been adopted owing to the danger of infection with infective hepatitis and other diseases.

EPIDEMIC PAROTITIS (MUMPS)

Etiology. The agent of epidemic parotitis is a filtrable virus. The parotitis virus is in many respects similar to the influenza viruses: it is readily cultivated in chick embryos and agglutinates the erythrocytes of hen and some animals due to the presence of a specific enzyme, neuraminidaze. The pathogenic agent of parotitis, together with the viruses of Newcastle disease and influenza D, belongs to the group of para-influenza viruses.

Outside the human organism, the parotitis virus is just as unstable as the agent of influenza. The strains of the parotitis virus, isolated in different places and at different times, have the same antigenic structure.

Pathogenesis. After entering the mouth and settling in the cells of the mucous membranes, the parotitis virus penetrates the salivary glands, from where it spreads throughout the organism with the blood stream. In epidemic parotitis the salivary glands are nearly always affected (the parotid, submaxillary and sublingual glands), sometimes the genital glands are involved (testes in men, ovaries in women) and the pancreas. Recently, nervous complications of parotitis—the development of serous meningitis—have often been noted. The virus is discharged from the organism in saliva.

Following an incubation period which varies from 11 to 23 days, but more often lasts 18 days, the disease takes a clinically manifested form; there are also inapparent forms and asymptomatic infections.

Infection with parotitis virus leads to the development of intensive immunity and the formation of virus-neutralis-

ing antibodies in the blood and tissular fluids. As in influenza, immunity is short-lived and this explains why reinfection of epidemic parotitis both among children and adults is frequent. The nature of the immunity, however, leads to the comparatively rapid freeing of the organism from the pathogen which is destroyed in one or two weeks from the onset of the disease.

Sources of Infection. Man is the sole natural reservoir of the epidemic parotitis virus. The main sources of infection are patients. Owing to the above-mentioned peculiarities of pathogenesis and immunity in parotitis, the patient becomes infectious in the final days of the incubation period. Epidemiological surveys and laboratory investigation prove that the discharge of the virus with saliva is discontinued between the sixth and the ninth days from the onset of the disease and then the patient is no longer infectious for others. The existence of inapparent forms and of asymptomatic infection has only recently been established. It may therefore be assumed that persons who have the asymptomatic infection become healthy carriers for a short time. However, their epidemiological significance as sources of infection is problematical. At the same time epidemiological studies indicate that patients suffering from epidemic parotitis are practically the sole, and at any rate the main, source of infection. There is no convalescent carrying or long healthy carrying in this disease.

Routes of Transmission. The infectious agent is transmitted with the saliva of patients. The main method of transmission, therefore, is through the saliva left on various objects. Such transmission is particularly frequent in children via toys, but adults may transmit infection in saliva left on crockery, cigarette butts, etc. The poor stability of the agent in the environment explains why infection is usually transmitted to those in close association with the patient (in a family, a children's institution, hostel, etc.).

Epidemiology. Susceptibility to epidemic parotitis is equally high in children and adults. The morbidity of epidemic parotitis is never as high as in typical droplet infections (influenza, measles), and the acquired immunity disappears rather rapidly; therefore the stratum of people immune to parotitis is insignificant. This is why parotitis morbidi-

ty is governed not by the level of immunity in the population but by the presence of sources of infection (patients) and by the degree of their contact with the people around them.

Epidemic parotitis is a world-wide disease. It is particularly widespread among children in the five to 15 age group.

Parotitis cases are more frequent in the cold season of the year, as is the case in infections with the air droplet mechanism of transmission. The periodicity of epidemics, characteristic of respiratory infections, is not observed in epidemic parotitis.

Laboratory Diagnosis. The clinical picture is usually so clear that laboratory diagnosis of epidemic parotitis is not resorted to, but it may become necessary in the event of complications, for instance, if serous meningitis sets in. The virus is then isolated from the saliva or cerebrospinal fluid by a method similar to that for isolating the influenza virus; for serological diagnosis blood sera taken at the beginning of the disease and in the convalescent stage is investigated to ascertain the increase in specific antibodies.

Prophylaxis. A. A. Smorodintsev's live vaccine is an effective means of prevention. The vaccine is administered subcutaneously in a dose of 0.3 ml, or still better, in two doses at two-week intervals. The epidemiological effectiveness of the vaccine is good.

Prophylaxis of epidemic parotitis should be based on the observance of general hygienic measures in children's institutions (nurseries, kindergartens), schools and hostels, and also by the development of hygienic habits in children.

A patient suffering from epidemic parotitis should be isolated at home. If the disease takes a severe course or if there is danger of infecting many people, the patient is hospitalised and placed in an infectious ward, preferably in a separate cubicle. Isolation continues until clinical manifestations disappear (nine days from the onset of the disease).

Children under ten years of age are segregated between the 11th and 21st days of contact with the patient, and during this period measures for the early detection of patients amongst those exposed to contagion should be taken. Disinfection in the foci of epidemic parotitis is not necessary.

SMALLPOX

Etiology. The causative agent of smallpox is a virus belonging to the group of variola viruses of man and animals. The cowpox virus, which has an identical antigenic structure, is closest to it, and this is used in the specific prophylaxis of smallpox. The virus of smallpox is relatively viable in the environment: it can survive for a period of several days to several weeks in the dried smallpox pustules and in pus which pollutes clothes and other objects. The virus remains viable for several months in glycerine, even if kept in a warm place, and is destroyed in a few minutes by phenol or formalin type disinfectants in standard concentrations. Heating to 60° C kills the virus in 30 minutes if it is in a liquid. When present in dry pus, the virus remains viable for a longer time, being protected by a protein covering.

Pathogenesis. The smallpox virus reaches the respiratory tract by the air-borne droplet method and settles in the mucous membranes. It then enters the blood, causing viremia and the formation of infectious granulomas—smallpox pustules—on the skin and the mucous membranes. The disease develops following an incubation period of nine to fourteen days. Smallpox rash passes through several states of devolopment, maculas, papules, vesicles, pustules and scabs, the latter dropping off in 30 to 40 days from the onset of the disease.

Sources of Infection. The infectious period ranges from 30 to 40 days from the beginning of the disease, since the viable virus can be found in the pox scabs throughout the period. The period is actually shorter, because

viremia and the discharge of the virus in the secretion of the respiratory tracts terminates one or two weeks earlier, the patients' infectivity thus considerably reduced. Recovery is accompanied by life-long immunity precluding the desease, or any forms of carrying. This is why the sole source of infection in smallpox is the patient.

There are two varieties of clinical smallpox—smallpox (*Variola major*) and alastrim (*Variola minor*). The latter takes a comparatively mild course, and has a low mortality rate (up to 40 per cent in smallpox, less than ten per cent in alastrim) and the pock marks rapidly heal without leaving scars. Alastrim is widespread in tropical countries but has also been imported into Europe. Smallpox and alastrim have complete cross-immunity.

Routes of Transmission. Smallpox is transmitted by the droplet method and also by direct contact or by contact with objects (linen) contaminated by the pus from pustules. In view of the stability of the smallpox virus, transmission by objects does occur, though the droplet method of transmission is the main one for this infection.

Epidemiology. Smallpox has been known since ancient times. Epidemics occurred in China, India and Egypt several millennia before our era. Smallpox was imported into Europe in the 13th century as a result of the Crusades, the development of commerce and navigation, and in subsequent centuries, particularly in the 16th, 17th and 18th centuries, it caused vast epidemics which took a toll of many millions of lives. The reduction in smallpox morbidity in Europe and other countries began only in the 19th century with the spread of smallpox vaccination introduced by Jenner. In colonial and dependent countries, however, smallpox control only commenced in the 20th century. Smallpox morbidity and mortality rates are still high in many countries of Asia, Africa and South America. Imported cases of smallpox from these countries to Europe and North America, where smallpox has ceased to be endemic, are observed every year.

Smallpox was widespread in Russia before the Revolution; the incidence ran into hundreds of thousands of cases a year, tens of thousands of which were fatal. In 1910 alone 51,874 people died from smallpox in the European part

of Russia. Only the central areas of the country were covered by smallpox vaccination and even there it was carried out mainly in the towns. Regular anti-smallpox campaigns were started with the advent of Soviet power, when in 1919 V. I. Lenin signed a decree making smallpox vaccination compulsory throughout the country. Thanks to systematic mass smallpox vaccination morbidity had dropped radically in the twenties and, following a big campaign of total smallpox vaccination carried out in the thirties, smallpox was completely wiped out by 1936 (Fig. 54). Since then there have been only sporadic cases of smallpox imported from adjacent countries (Afghanistan, Iran, India); the infection, however, has not spread beyond limited areas and has been confined to isolated cases or small outbreaks.

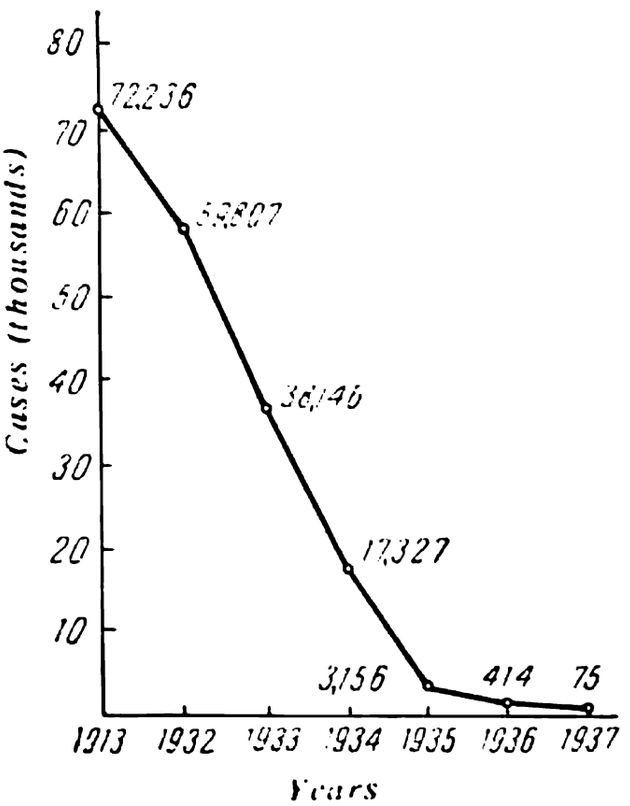


Fig. 54. Eradication of smallpox in the U.S.S.R.

Laboratory Diagnosis. Smallpox virus is isolated on chick embryos and in tissue cultures. Paul's test is used to distinguish smallpox from serious cases of chicken pox. The material from pustules (vesicles) is injected into the cornea of a rabbit; in 48 hours the eye is removed and a solution of sublimate is applied. In smallpox there are distinct lesions absent in chicken pox. The two viruses are also differentiated in tissue cultures.

Prophylaxis. Prophylaxis of smallpox is based on vaccination, quarantine measures to prevent importation from other countries and anti-epidemic measures to suppress a possible smallpox focus.

Attempts to use preventive vaccination against smallpox were made in ancient times by variolation—artificial infection with material taken from smallpox patients. In

China, smallpox scabs were introduced into the nasal tracts, and in Europe, the pustular fluid was rubbed into scarificated skin. It was discovered that as a rule this method of infection resulted in a milder course of the disease than from natural infection. However, in many cases of variolation, smallpox took the usual severe course and the inoculated persons became sources of infection for other people. Variolation, therefore, did not become a widespread measure of smallpox control.

Towards the end of the 18th century Jenner, an English physician, used the material from a pustule of a cowpox patient to inoculate another person against smallpox. The virus of cowpox is similar to the virus of smallpox in its antigenic structure and develops cross-immunity. However, unlike smallpox, cowpox infection takes a local and benign course in man, developing pustules only at the site of the inoculation of the infectious material. Formerly, cowpox was an occupational disease. Jenner saw the significance of this and successfully used cowpox vaccination as a means of protection against smallpox. This discovery marked a new stage in the struggle against smallpox and following the publication of Jenner's experiments (1892) smallpox vaccination gradually began to be practised all over the world.

Nowadays the preparation of smallpox vaccines has been considerably simplified. The vaccine is made by infecting heifers with a vaccinal strain of the virus; material is subsequently taken from the developing pustules (detritus) and the vaccine is dried in a vacuum, which increases its period of viability. In addition to heifer lymph vaccine, a vaccine made by infecting chick embryos is also used.

Vaccination is usually performed by placing a drop of lymph on the skin of the upper part of the left arm and introducing it by scarification. The vaccine is diluted in a physiological solution or in distilled water to the volume indicated on the label of the ampule. The appropriate skin area is cleansed by alcohol or ether, and following inoculation the lymph should be allowed to dry.

Primary vaccination is given to children of three months to one year, revaccinations are carried out at the ages of 4, 7, 12 and 17-18. For epidemiological indications revaccination may be done at any age. In primary vaccination the

organism responds with a slight fever and a local process, duplicating in a mild form the main stages of cowpox infection; the vesicles, as a rule, do not suppurate. In revaccination the process is even milder and there is no fever. The vesicles do not develop if the vaccinated person has good immunity against smallpox or if the vaccination has not been carried out properly.

The majority of countries are parties to the international convention for preventing the importation of smallpox from other countries. Its latest text was endorsed by the World Health Organisation in 1952. Under this convention countries are obliged to give timely notification of smallpox cases, persons arriving in or leaving countries where smallpox is present have to be vaccinated, quarantine measures have to be taken with regard to passengers of vessels and other means of transport, on board of which smallpox cases have been detected.

Upon detection of a smallpox case the higher public health bodies should be immediately informed. The patient should be isolated in a separate cubicle and placed under the observation of specially trained medical staff. Contacts are isolated for 14 days from the time of contact. Prophylactically, it is expedient to give contacts anti-smallpox gamma globulin and to vaccinate them. The premises in which the patient is isolated and the ward in which he is treated are thoroughly disinfected by washing and wiping with a damp cloth, and objects and linen are subjected to chamber disinfection.

TYPHUS FEVER

Etiology. The pathogenic agent of typhus fever—*Rickettsia prowazeki*—is one of a group of rickettsias—microorganisms intermediate between bacteria and viruses. *Rickettsiae prowazeki* belong to the vast group of agents of spotted fevers, characterised by an antigenic similarity which indicates a common origin. *Rickettsiae prowazeki* are unstable in environment. Exposure to direct sunlight, heating to 50° C and disinfectants in standard concentrations destroy them in a few minutes. However, rickettsias can remain viable for several weeks in the feces of desiccated lice.

Pathogenesis. The portal of entry in typhus fever is the skin, and less frequently the mucous membranes. On arrival in the lymph or the blood vessels the rickettsias multiply in the epithelium of the capillaries and cause the development of petechial rash and infectious granulomas which are characteristic of typhus fever. The disease develops after an incubation period of 11-14 days and is manifested in the form of rickettsiemia with a fever, a rash, and the development of microlesions in the brain vessels and internal organs. The febrile period lasts for some two weeks followed by gradual recovery. The patient is infectious while febrile. With the termination of the fever, rickettsias disappear from the blood and life-long immunity develops. Susceptibility to typhus fever among non-immune persons is universal.

This concept of the pathogenesis and immunity in typhus fever is now being reconsidered because repeated infections have been observed in areas where the disease has been absent. In some cases a thorough epidemiological survey ruled out the possibility of infec-

tion being transmitted by lice from patients. On the basis of such observations Zinsser has advanced a theory of relapses in typhus fever. According to this theory, some people who have had typhus fever are not freed from rickettsias, which persist in their organism for many years, and the latent infection, under the influence of various factors, may lead to a relapse. As a rule, relapses of typhus fever (frequently called Brill's disease after the physician who described these cases) take a milder course, but in all other respects are similar to ordinary typhus fever. Brill's disease was observed in the United States in the twenties among immigrants from East Europe. In the post-war years similar diseases were observed in some West European countries where typhus fever was believed to have been eradicated; Brill's disease was observed in persons who had suffered from typhus fever during the Second World War.

The theory of relapse in recurrent typhus fever was confirmed by experiment when Price isolated rickettsias from lymph nodes of healthy people who had suffered from typhus fever in the past.

Sources of Infection. The sources of typhus fever are patients from the final days of the incubation period and throughout the febrile period. Another potential source is persons who harbour rickettsias in a latent form; they are likewise infectious during the acute period of the typhus fever relapse.

Routes of Transmission. Typhus fever is transmitted by lice. Of the three species of lice which are parasitic on man the main vector of typhus fever is the body louse (*Pediculus vestimenti*). Of considerably smaller epidemiological significance is the head louse (*Peduculus capitis*), though it has been proved that typhus fever rickettsias can be transmitted by this species. The pubic louse (*Phthirius pubis*) is not a vector of typhus fever.

The louse becomes infected with *Rickettsiae prowazeki* when it sucks the blood of a typhus fever patient. The rickettsias reach the intestine of the louse, multiply in its epithelium, accumulate in great quantities in the cells and cause their desquamation in the intestinal lumen. This takes four or five days and then the louse becomes infectious. An infected louse lives for three or four weeks instead of the ordinary six to eight weeks and then dies, mainly due to gastrorrhexis—the rupture of the intestine by rickettsias which have multiplied in the epithelium. Defecation takes place during blood-sucking and since itch-causing saliva is excreted by the louse during the bite, the infected rickettsias are rubbed into

the skin by scratching or are transmitted to the mucous membranes of the eyes with resultant infection with typhus fever. Infection through the respiratory tract is also theoretically possible when dry feces of lice infected with rickettsias reach the respiratory tract with dust. Such rare cases of infection may be found among the staff of the disinfection service. Respiratory tract infection sometimes occurs in laboratories, as a result of the handling of mice infected with rickettsias intranasally. The mice are infected for research purposes and also for the preparation of typhus fever vaccine.

Epidemiology. The continuity of the epidemic process in typhus fever is ensured by the alternating presence of rickettsias in the organisms of man and louse. Man is infectious for 15-18 days after the onset of the disease, while the infected louse lives for a month and the incubation period lasts up to two weeks; typhus fever focus can therefore exist for two months after the appearance of the disease. The appearance of the disease in a focus after a longer interval proves that there is another source of infection.

Typhus fever has been known since ancient times. Wars, crop failures and other social upheavals associated with migration of population and an increase of pediculosis have frequently been accompanied by typhus fever epidemics. Under capitalism typhus fever affects mainly the poorer sections of the population where there is more overcrowding and insanitary conditions. In the hystory of wars there have been terrible epidemics of typhus fever which took a great toll of human life.

During the war of 1505-30, approximately 30,000 of the French troops which besieged Naples died from typhus fever. During the Napoleonic wars, in 1813-14 more than two million people had typhus fever in Germany alone. Particularly vast epidemics of typhus fever took place during the First World War and during the Civil War in the U.S.S.R. According to approximate estimates some 6.2 million people suffered from typhus fever from 1918 to 1920 in the U.S.S.R. (Fig. 55). There were also considerable epidemics of typhus fever during the Second World War, particularly in the territories occupied by the German troops. The Nazi army was hit hard by typhus fever.

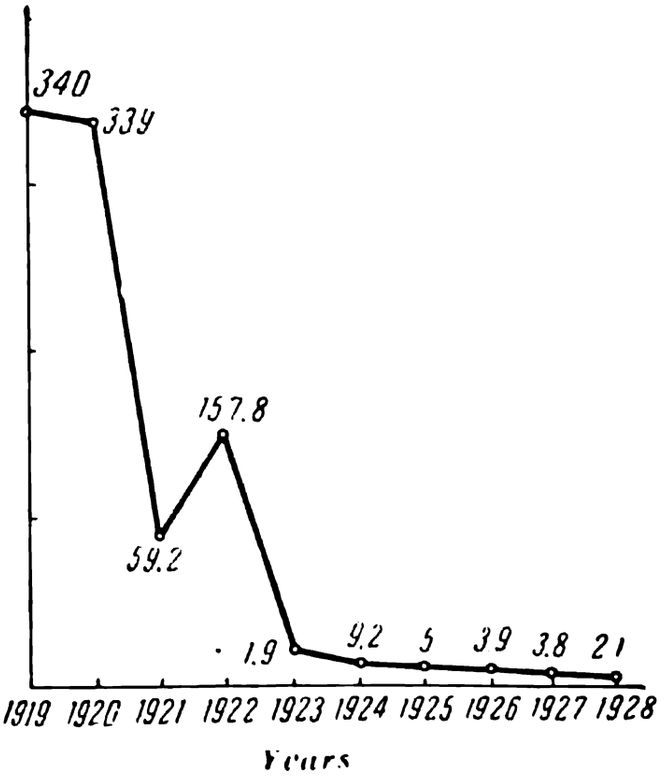


Fig. 55. Typhus fever epidemic in the Civil War in the U.S.S.R. (per 10,000 of population)

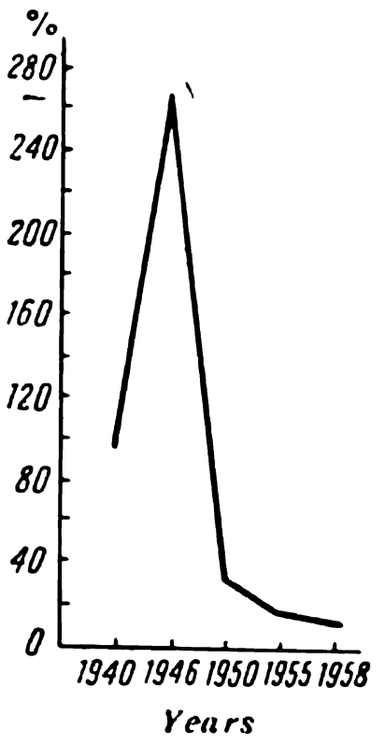


Fig. 56. Eradication of epidemic forms of typhus fever in the U.S.S.R. (incidence in 1940—100 per cent)

The situation in the Soviet Army was different in this respect because the well-organised anti-epidemic service in the army prevented typhus cases from developing into epidemics.

At present, typhus fever occurs mainly in the underdeveloped and colonial countries. Since the war there has been a general downward trend in typhus fever morbidity.

Ever since the big epidemic during the Civil War, the morbidity of typhus fever in the U.S.S.R. has been steadily declining. There was a certain rise in the thirties owing to big shifts in population. During the Second World War and in the immediate post-war years typhus fever epidemics took place in the areas which had been under German occupation. Subsequently typhus fever morbidity has shown a continual downward trend, reaching a minimum in the early fifties (Fig. 56).

By this time epidemic outbreaks of typhus fever had been suppressed and morbidity acquired the nature of sporadic cases: according to K. N. Tokarevich and G. S. Mosing, most of them affected people who had suffered from the disease previously; hence the mildness of the course. These scien-

tists believe that the cases were of a relapsing nature, though other epidemiologists (V. V. Pshenichnov, I. I. Shatrov) disagree with this opinion.

Laboratory Diagnosis. In addition to isolating rickettsias from patients (by infecting mice, chick embryos and lice) laboratory diagnosis of typhus fever is based mainly upon serological reactions. The most accurate results are obtained in agglutination of rickettsias with patients' sera withdrawn in the second week of the disease or later (specimens from rickettsias are prepared for this purpose). Less accurate results are obtained when specimens are made of *Proteus* X_{19}, which has common antigens with rickettsias.

Prophylaxis. Prophylaxis of typhus fever is based on general sanitary measures against pediculosis, anti-epidemic measures in typhus fever foci and prophylactic vaccination.

Since lice are vectors of typhus fever, their eradication is an important measure in the system of typhus fever control. Naturally, improvement in the welfare and the cultural standards of the people, development of bath-houses and laundry services are basic means of pediculosis control. A proof of it is the gradual disappearance of pediculosis among the population of the Soviet Union. Particular attention, however, has to be given to the problem in time of war, and in the medico-sanitary care of certain sections of the population—seasonal and building workers, etc. In these cases it is necessary to establish bath-houses with sanitary inspection and disinfection centres, so as to prevent the spread of pediculosis among the sections of the population served by these establishments. Sanitary disinfection posts at railroad junctions, whose work is particularly important in time of war, also serve this purpose. Besides the development of bath-house and laundry services, it is expedient to use insecticides of the DDT type in dust form, and to impregnate clothes and underwear with them if pediculosis appears among certain groups of the population.

A patient suffering from typhus fever is isolated in an infectious diseases hospital with preliminary chamber disinfection of all clothing. The district sanitary-epidemiological station is notified immediately of every case of typhus fever. Clothing and bedding are subjected to chamber disinfection in the focus where the patient was detected, while the pre-

mises and the objects found there are cleared of insects by washing with insecticide or by spraying with DDT dust. Any contacts of the patient are placed under medical observation for 45 days from the isolation of the patient, or 60 days from the onset of the disease. A thorough epidemiological survey has to be carried out to define the limits of the focus, since the patient may have been in contact not only with the residents of the given flat or hostel but with persons living elsewhere. All of them have to undergo sanitary treatment, including the washing and delousing of all clothing.

On the discovery of typhus fever in a given locality, active measures have to be taken for the detection of patients by house-to-house visits, and by using various means of health education to enlighten the population. Provisional hospitalisation of febrile patients (those who run a temperature for more than three or five days) is very effective, since it excludes the spread of infection.

Preventative inoculation against typhus fever is resorted to only in a particularly dangerous epidemiological situation and also to protect persons exposed to typhus fever infection (those working in the disinfection service, bath-houses and laundries, rickettsial laboratories, etc.). Two types of vaccines are used: one of them (Krontovskaya-Mayevsky vaccine) is made from mice lungs infected with rickettsias, the other (Cox vaccine) is made from rickettsia-infected chick embryos. Inoculation is made subcutaneously, two doses of one ml of vaccine being given with a two or three week interval. Morbidity amongst those inoculated is one half or one third of that occurring among those not inoculated and the disease takes a considerably milder form.

RICKETTSIAL INFECTIONS

Besides the epidemic louse-borne typhus fever there are other infections caused by rickettsias. Some take a similar course to typhus fever, others differ considerably from it. All rickettsial infections are zoonoses.

Rickettsial infections may be subdivided into several groups according to etiology and epidemiological characteristics.

The typhus fever group includes: 1) murine flea-borne typhus; 2) rickettsialpox; 3) Mediterranean fever (Marseilles fever); 4) Siberian tick typhus; 5) Rocky Mountain spotted fever.

Characteristic of this group is a similarity of pathogens and antigenic structure, and their ecological properties are also closely related. This group of pathogens is thought to have a common origin, while the differing nosological forms are the result of the long evolution of the pathogens in various geographical and historical conditions. It has been found that the tick-borne rickettsial infections are the oldest in origin, while murine flea-borne typhus and louse-borne typhus fever developed at a much later date under the influence of man's activity.

The tsutsugamushi group consists of one nosological category of the same name, also called scrub typhus.

The group of the five-day trench fever, also called Volhynia fever, includes, in addition to five-day fever, paroxysmal (tick-borne) rickettsiosis.

The Q-fever group consists of one nosological category of the same name.

Natural foci of rickettsial infections are found all over the world. The majority of the above-mentioned infections also occur in the U.S.S.R. They were discovered and studied by P. F. Zdrodovsky, Y. M. Golinevich, M. K. Krontovskaya, S. M. Kulagin, G. S. Mosing, M. P. Chumakov, V. M. Zhdanov and other Soviet researchers.

Murine Flea-borne Typhus. The agent of murine flea-borne typhus is *R. mooseri*, serologically very similar to *R. prowazeki*. They are more pathogenic for test animals, evoke a characteristic periorchitis (the scrotal phenomenon) in guinea pigs, and have several other features which distinguish them from *R. prowazeki*.

The clinical picture and pathogenesis are basically similar to those of typhus fever, but there are certain peculiarities differentiating the two infections. The diagnosis is established by serological tests but the great similarity of the antigenic structure of *R. prowazeki* and *R. mooseri* causes patients' sera to agglutinate both species of rickettsias, and the complement fixation test shows only a slight difference in the titre. The Weil-Felix reaction is unsuitable for diagnosing murine typhus.

The reservoir of the causative agent is rats and mice. The infection does not kill them and the rickettsias are preserved for a long time in their organisms; they circulate in the blood and are discharged in urine. The animals are mainly infected by fleas which are parasitic on rodents. An additional factor in the dissemination of the agent is the urine.

Man is infected mainly through fleas and on the whole the mechanism of infection resembles that of louse-borne typhus fever. There are indications that infection can be transmitted with products contaminated by the urine of infected rats.

Foci of murine flea-borne typhus are found on all continents, but mainly in areas with a hot or warm climate which seems to facilitate the mass breeding of fleas parasitic on rats.

The areas of murine flea-borne typhus foci coincide to a large extent with the areas of murine plague foci; in the main they are confined to port towns. However, foci of murine flea-borne typhus are also found in inland areas (U.S.A.,

North China). In the southern part of the U.S.A., foci of murine flea-borne typhus exist not only in towns but in rural areas where there are rats.

In the U.S.S.R., foci of this infection have been found in south coast towns of the Black and the Caspian seas.

Cases of murine flea-borne typhus are as a rule of a sporadic character. They mostly occur in the warm season of the year, which is the active period of the flea.

Prophylaxis of murine flea-borne typhus consists of the systematic extermination of rats and the use of flea-control measures (primarily the treatment of premises with insecticides).

The patients are hospitalised if there are clinical reasons for it. No other measures are taken in the foci. Vaccines have been suggested which are prepared in a similar way to those against typhus fever, but the need for inoculation arises only in exceptional circumstances.

Rickettsialpox. The pathogenic agent of rickettsialpox is a species of rickettsia (*R. akari*), serologically akin to the rickettsia of the Mediterranean fever group and with a certain similarity to *R. prowazeki* and *R. moozeri.*

Rickettsialpox was discovered by Huebner and his collaborators near New York, where there was a considerable outbreak of this infection. In 1950 it was found in some towns in the Donbas area (V. M. Zhdanov and collaborators, S. M. Kulagin). Subsequently rickettsialpox was registered in several parts of the U.S.A. and in Africa.

A distinguishing symptom is a papular-vesicular rash, somewhat resembling the rash in smallpox and chicken pox; hence the name of the disease. Another peculiarity is the development of an initial symptom, several days before the onset of the disease, in the form of a necrotic inflammation at the site of the tick bite. Serological diagnosis is established by agglutination reaction or by the complement fixation test.

The reservoir of the pathogen is mice and rats, which are, apparently, carriers of rickettsias over long periods. In animals the infection takes a relatively mild, non-lethal course. The vectors of rickettsias are gamasoid ticks (*Allodermanyssus sanguineus*), which infect man or animal during biting and blood-sucking.

The main habitat of mice is dwellings and auxiliary structures, and the foci of rickettsialpox are, therefore, found in inhabited localities, most frequently in towns. People contract the disease in spring and early summer, which corresponds to the period of activity of the mite. Epidemiological survey leads to the discovery of rodents in dwellings, and an investigation of rodents and of the mites found on them shows that the rodents have been infected by this pathogen. There are often multiple infections in the foci.

Prophylaxis of rickettsialpox involves the same measures as the prophylaxis of murine flea-borne typhus (extermination of rodents, tick control by insecticides). Preventative inoculation is not used.

Mediterranean (Marseilles) Fever. The causative agent of this infection is *R. conori*, which is a number of a group of rickettsias with similar antigenic structures. This is why serological differentiation in this group of diseases is extremely difficult; Mediterranean fever and the Siberian tick typhus, for instance, cannot be differentiated by this method.

Mediterranean fever takes the form of a febrile condition with a maculo-papular rash. The development of the disease is preceded by the initial symptom, a necrotic inflammation at the site of the tick bite.

Mediterranean fever is probably a zoonosis, though the animal reservoirs of the pathogen have not been definitely determined. The vector is the dog tick *Rhipicephalus sanguineus*. Infection occurs during the bite. Mediterranean fever is very widespread and is found in all countries of the Mediterranean and the Black Sea coast of the Near East.

South African fever, which is widespread in Equatorial and South Africa, is probably identical with Mediterranean fever or is a variant of it. In the U.S.S.R., Mediterranean fever is found along the southern coast of the Crimea.

Morbidity is usually of a sporadic nature and outbreaks are rare. Since the vector of this infection is the dog tick, the disease frequently afflicts dog-owners. The infection is more frequent in the spring and summer months.

Prophylaxis consists in tick-control measures and protection against attacks by ticks. Besides disinfecting pre-

mises, it is necessary to protect dogs and other domestic animals against ticks. Inoculation is possible (a vaccine of the type of typhus fever vaccine can be produced), but is not usually practiced.

Siberian Tick Typhus. The agent of Siberian tick typhus (*Rickettsia sibirica*) is very close to Mediterranean fever rickettsias (M. K. Krontovskaya). Unlike other rickettsial infections whose agents lodge only in the protoplasm of the affected cells, *Rickettsia sibirica* settles in the cell nuclei.

The pathogenesis and the clinical picture of Siberian tick typhus is on the whole similar to those of Mediterranean fever. Siberian tick typhus is a natural foci infection. The reservoir of the pathogen is small mouse-like rodent, the vectors are *Ixodidae* ticks of the *Dermacentor* genus and others. Infection is transmitted by a tick bite.

Siberian tick typhus occurs over a vast area of Siberia and the Far East in forest and forest-steppe areas. Morbidity is of a sporadic nature. In the main farmers or people who work in forests are affected. Most cases occur during the spring and summer months when the vector ticks become particularly active.

Prophylaxis consists chiefly in the use of protective measures against attacks by ticks. Inoculation is not practiced. The patient has to be hospitalised and is discharged on clinical recovery.

Rocky Mountain Spotted Fever. The most important of all similar forms of tick-borne rickettsial infections in the pathology of man is the American tick-borne fever, usually known as Rocky Mountain spotted fever. In addition to the area where it was first located and from which it takes its name, this rickettsial infection is widespread over a large part of North America, in Brazil and in other Latin American countries.

The biological and serological properties of the agent of Rocky Mountain spotted fever (*Rickettsia rickettsii*) are similar to those of other representatives of this group. The disease takes a more serious course than other forms of tick-borne rickettsial infections. The natural reservoirs of the pathogen have not been defined; evidently they are rodents. The vector is the *Dermacentor andersoni* tick and

other species of the Ixodidae tick. Measures of prophylaxis are similar to those used in other tick-borne rickettsial infections.

Tsutsugamushi. The agent of tsutsugamushi fever (otherwise known as Japanese river fever, jungle fever or scrub typhus) is *Rickettsia orientalis*, which differs from other rickettsias in antigenic structure and other biological properties. The infection takes the course of an acute febrile condition with a rash. Its severity varies—mortality ranges from one to 60 per cent depending on the area. Recovery is accompanied by the development of a life-long immunity.

Tsutsugamushi is a natural foci infection. The reservoir is found in mouse-like rodents and the vector is the larva of the *Trombicula* tick. These ticks are blood-suckers only in the larval phase. Infection occurs during the bite.

Tsutsugamushi occurs in vast areas in East and South-East Asia (Japan, South China, the Philippines, Malaya, India, Indonesia), in North Australia and in several islands of Oceania. The disease attracted attention during the Second World War when considerable epidemics occurred among Anglo-American troops. It is not found in the U.S.S.R.

Prophylaxis is based on the extermination of ticks and on protection against their attacks. Inoculation is also advisable.

Five-day Fever and Paroxysmal Rickettsiosis. This disease takes the form of febrile attacks lasting on the average five days (hence one of the names of the disease). The attacks recur after a period of remission. There is no rash.

The disease is transmitted from man to man by lice and, like in typhus fever, infection is the result not of the bite, but of rubbing the contents of a louse's intestine into the skin. The agent of the disease (*Rickettsia quintanae*), unlike *R. prowazeki*, does not lodge within the epithelium cells of the louse's intestine but on their surface.

Five-day, or trench fever became known in 1915 when epidemics of this disease involving more than a million men occurred among the troops of various countries in the course of trench warfare.

Beginning on the Eastern Front (Volhynia fever) it spread to the Western Front troops. When the war ended the disease disappeared almost completely.

It reappeared during the Second World War. The epidemic which was much smaller than the first mainly affected the German Army on the Eastern Front. Subsequently, isolated cases of five-day fever were recorded in Moldavia and in other parts of the U.S.S.R. The disease disappeared by 1949.

An infection with a clinical picture similar to five-day fever—paroxysmal rickettsiasis—was encountered in 1947 in western districts of the Ukraine. It subsequently transpired that the agent is a rickettsia greatly resembling *Rickettsia quintanae.* The diseases were associated with work in the forest and some of the patients reported tick bites. Investigators isolated identical strains of rickettsias from the blood of patients, from ticks caught in timbering areas and from lice found on patients. The isolated rickettsias adapted themselves easily to the organism of lice.

In 1954 these areas were again investigated by G. S. Mosing, whose experiments led him to the conclusion that the two diseases were identical. According to Mosing, Volhynia fever exists in the form of a natural foci tick-borne rickettsiasis, which under similar conditions had caused two epidemics in which these infections were transmitted by lice.

Prophylaxis of five-day fever involves measures similar to those for epidemic typhus. The prophylaxis of paroxysmal rickettsias consists in tick control and protection against attacks by ticks.

Q-fever. The first cases of Q-fever were described in Australia in 1937, the letter "Q" meaning "query". Subsequently the disease was found in the U.S.A. and in other countries. Another name for the disease—pneumorickettsiasis—was suggested by P. F. Zdrodovsky.

The agents of Q-fever are tiny rickettsias (*Coxiella s. Rickettsia burneti*) which pass through bacterial filters (hence another name, *Rickettsia diaporica*). Burnet's rickettsia are extremely stable in external environment and remain viable in a dried state for several weeks or months.

Q-fever takes the form of a general febrile condition without a rash and frequently involves the lungs (atypical interstitial pneumonia). The incubation period ranges from a few days to 10-14 days.

The epidemiology of Q-fever is varied. It is probable that this infection also has natural foci; the reservoir of the pathogen is rodents and other vertebrates, while Ixodidae ticks are the vectors.

However, in addition to being a natural foci disease, Q-fever is a zoonosis of cows and sheep. The latter sources

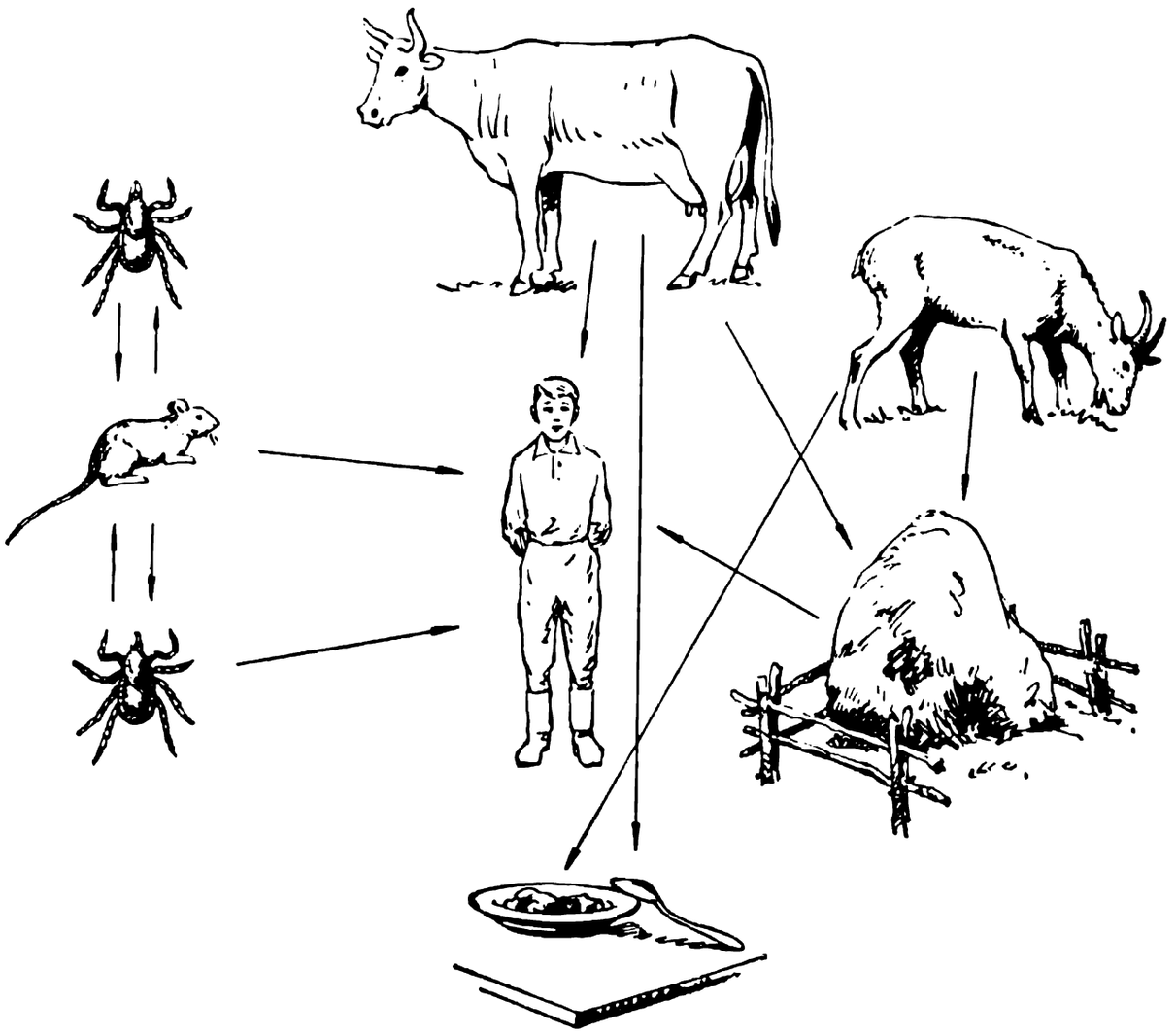


Fig. 57. Circulation of Q-fever rickettsias

of infection are of great significance in its epidemiology. The infected animals discharge *R. burneti* in urine and milk, and can infect pasture ticks which feed on their blood (Fig. 57).

There are several ways in which man can contract Q-fever: 1) By a bite of an infected tick, 2) by drinking milk of sick animals, 3) while tending animals (shepherds, milk-maids) or in slaughtering and meat-dressing (slaughter-house

workers), 4) by the dust-borne method (wool, mats contaminated by rickettsias). The most frequent types of infection are occupation and alimentary.

Shortly after the discovery of Q-fever it was found that this disease is widespread. Some diseases with obscure etiology, Balkan flu, for instance, which was found in Greece and in other Balkan countries, proved to be Q-fever. The epidemic of "atypical" pneumonia which had occurred among the Anglo-American troops in Sicily and in Italy during the Second World War was also found to be an epidemic of Q-fever.

At present, Q-fever foci are found in almost all countries.

Besides clinical diagnosis, which is rather difficult, serological tests (complement fixation test) are used to differentiate this infection.

The prophylaxis of Q-fever requires further study. It is particularly difficult to eradicate it among farm animals. Better progress is being made in its prevention among humans: the measures include the wearing of special clothes and the observance of rules of personal hygiene by the staff of cattle farms, pasteurisation of milk arriving from farms afflicted with Q-fever, disinfection of wool and other objects in the focus. Specific immunisation is also required for the population of the areas where this infection is widespread, priority should be given to cattle workers and those employed at meat-packing plants. Hospitalisation and treatment depend on clinical indications.

RELAPSING FEVER

Etiology. Relapsing fever is caused by Obermeier's spirochete (*Borrella recurrentis*), which belongs to the group of agents of relapsing fevers (spirochetoses) of man and animals. The spirochete of relapsing fever is unstable in environment and is viable only in the organism of man and louse.

Pathogenesis. The portal of entry is skin abrasions and the mucous membranes of the eyes. The spirochete enters the blood stream, where it multiplies accumulating in the capillaries of the internal organs and circulating in the general blood stream. The disease develops after a five to seven day incubation period which, however, may be longer. The infection takes the form of a fever, lesions of the liver and the spleen, jaundice and hemophilic symptoms. In five or seven days the attack remits for seven or eight days and is as a rule followed by several briefer attacks (from one to four) which are separated by longer remission periods.

The spirochetes are easy to detect in the blood during an attack but are rarely to be found during a remission. The explanation is that by the end of the attack the antibodies produced in the patient's organism destroy the spirochetes. The new generation of spirochetes which were produced during the remission period is resistant to those antibodies and is destroyed by the antibodies produced by the end of the second attack, etc. Since the spirochetes remain in the organism of the patient during the remission period, the patient is infectious in that period, though the degree of infectivity drops considerably. To calculate the infectious period of a patient, it is necessary to add three

weeks, the maximum time of the possible next remission, after the termination of an attack.

Susceptibility to relapsing fever is universal. Immunity is practically non-existent, since the antibodies produced in the organism are exclusively specific to the strain which causes the infection and even to individual generations of this strain, and thus do not protect against reinfection. This, however, is not altogether true, since a certain degree of general immunity to Obermeier's spirochetes does develop in people who have had the infection. This can be confirmed by the discovery in the blood of antibodies which produce the Brusin-Rieckenberg reaction; owing to the presence of these antibodies reinfection with relapsing fever is mild and as a rule there is only one recurrence.

Sources of Infection. The source of infection in relapsing fever is the patient, both during the attack and in remission. There is no carrying in relapsing fever.

Routes of Transmission. The vector of relapsing fever is the body louse (*Pediculus vestimenti*); transmission by the head louse (*Pediculus capitis*) is also possible. The mechanism of infection in relapsing fever is different from that of typhus fever. The spirochetes, which reach the intestine of a louse with the blood of the patient, penetrate the walls of the intestine and invade the internal body cavity where they multiply in the hemolymph and tissues and accumulate in great quantities. From the fifth day after feeding on the blood of the patient the louse becomes infectious. Infection occurs when the louse is crushed or injured and the hemolymph with the spirochetes is rubbed into the skin by scratching or gets into the mucous membrane of the eye. Thus it is more difficult to contract relapsing fever than typhus fever, which explains why epidemics of relapsing fever occur only in appalling sanitary conditions when there is wholesale pediculosis.

Epidemiology. Before the Revolution relapsing fever was widespread in Russia mainly among the poor, who lived in extremely crowded conditions and where pediculosis was common. During the Civil War epidemics of relapsing fever developed on a tremendous scale. According to approximate estimates 3.2 million people had relapsing fever in 1918-22. After the Civil War, epidemics of relapsing fever were sup-

pressed and after a certain rise in morbidity in the early thirties, this infection was eradicated in the U.S.S.R. by the beginning of the war (1940). Towards the close of the Second World War relapsing fever was imported to Soviet Central Asian Republics from Iran and thence to the Ukraine and adjacent areas by former evacuees. However, by 1951 relapsing fever was again eradicated throughout the country.

At present relapsing fever is found in the Near East, in South-East Asia, North Africa and in some other countries.

Laboratory Diagnosis. Laboratory diagnosis of relapsing fever is established by bacteriological examination of smears and thick drops of blood withdrawn from the patient at the time of an attack. On rare occasions the Brusin-Rieckenberg test is used to discover thrombocytobarines in convalescent blood serum.

Prophylaxis. Prophylaxis and control of relapsing fever are as in typhus fever. Therefore, when there are cases of relapsing fever, measures of prevention and control are taken concurrently against both typhus fever and relapsing fever.

Some of the measures taken with regard to relapsing fever are determined by the peculiarities of the source of infection. The patient has to be isolated in an infectious diseases ward while febrile and for another 20 days from the termination of the attack. The district sanitary-epidemiological station is immediately notified following diagnosis of a case of relapsing fever. The focus is kept under observation for six weeks, the first 12 days—the maximum incubation period—being decisive for the detection of patients. Sanitary treatment of a relapsing fever focus is similar to the measures taken in typhus fever.

TICK-BORNE SPIROCHETOSES

There is a considerable number of tick-borne spirochetoses in different parts of the world, all caused by spirochetes similar to the pathogen of relapsing fever. The reservoir of the pathogens in nature are small mouse-like rodents; the vectors are ticks of the *Ornithodorus* genus.

The majority of tick-borne spirochetoses are found in sparsely populated, undeveloped areas, and man is infected accidentally when entering the natural foci. It is characteristic of some spirochetoses that their vectors—*Ornithodorus* ticks—infest man's dwellings and other structures, feeding on man's blood and on the blood of domestic animals. In these cases the foci of tick-borne spirochetosis are found in populated areas. There are two forms of tick-borne spirochetosis in the U.S.S.R. and the credit for studying them belongs to Y. I. Martsinovsky, N. I. Latyshev and other Soviet investigators.

Central Asian Tick-borne Relapsing Fever. The causative agent (*Borrellia sogdiana*) is pathogenic for many species of rodents. Pathogenesis is similar to that in epidemic louse-borne relapsing fever.

The clinical course also resembles that of louse-borne relapsing fever but with several distinctions. The attacks of fever last one or two days, sometimes a few hours; the remissions are irregular, lasting from a few hours to six or eight days. There is no regularity in the alternation of attacks and apyrexias. There may be more than ten attacks and the disease may persist for several months; it

always takes a purely benign form and a fatal outcome is extremely rare.

The reservoir is mouse-like rodents (gebrils): rats, mice, hamsters and shrews.

The vectors are ticks, *Ornithodorus papillipes*, which harbour the spirochetes for long periods of time, transmitting them transovarially. The spirochetes penetrate the cavity of the body from the intestine of ticks and accumulate in the coxal glands. During the bite the tick ejects the coxal fluid which enters the wound and the spirochetes invade the blood stream. The method of infection is identical for animals and human beings.

Morbidity is characterised by a well-pronounced seasonal pattern. All cases originate in warm weather, mainly in spring. They generally occur in rural communities where ticks inhabit mud houses, and less frequently in undeveloped areas.

Caucasian Tick-borne Relapsing Fever. The agent (*Borrellia caucasica*) is pathogenic for many species of rodents.

Pathogenesis and clinical picture are identical to those of Central Asian relapsing fever.

The reservoirs of the pathogen in nature are rodents: the wood vole, Caucasian shrew, house mouse, jerboa.

Vectors are ticks *Ornithodorus verrucosus*. The mechanism of infection is the same as in Central Asian relapsing fever. As distinct from *Ornithodorus papillipes*, this tick lives only in a wild natural habitat (caves, burrows of small animals).

The disease occurs sporadically and in the form of outbreaks among the people working in undeveloped areas: prospectors, road builders, travellers, parties of explorers, etc.

Prophylaxis. Prophylaxis of tick-borne spirochetosis in wild country consists in protection against attacks by ticks. People in natural foci of tick-borne relapsing fever should select sleeping-places which are free of ticks and away from burrows of rodents. It is advisable to avoid places with dense brush and grass or to clear these from the place chosen for sleeping. It is also advisable to treat these places with insecticides (DDT) or by repellents (lysol, cresols). For in-

dividual protection repellents have to be used (dimethylphthalate, and others).

Where tick-borne spirochetosis is entrenched in communities, DDT and hexachlorocyclohexane preparations have to be used to destroy ticks in dwellings and other structures and measures to control tick infestation of domestic animals have to be taken. Regular extermination of rodents and ticks and the construction of good rural housing eradicate stable foci of tick-borne spirochetosis in communities.

MALARIA

Etiology. There are four forms of malaria caused by protozoan organisms of one genus—malarial plasmodia: tertian malaria (*Plasmodium vivax*), quartan malaria (*Plasmodium malariae*), tropical or malignant malaria (*Plasmodium falciparum*) and ovale malaria, occurring in tropical countries, which is caused by *Plasmodium ovale* (this form has not been found in the U.S.S.R.).

Pathogenesis. The malaria parasite undergoes a complex development cycle in the organism of the mosquito and man. Infection occurs following a bite by an infected female mosquito which contains sporozoites in the salivary glands. When malaria parasites arrive in the blood of man they undergo an asexual cycle of multiplication (schyzogony) in tissues and erythrocytes. The exoerythrocytic stage of development has not as yet been sufficiently studied. It takes place in the reticulo-endothelium of the liver, in the endothelium of the brain capillaries and in the tissue macrophages. In all probability this is not merely the initial stage of malarial infection but is responsible for the survival of the parasite in the organism. The main symptoms of malarial infection, however, are associated with the multiplication of the parasite in the erythrocytes.

Upon reaching the mesenchimal cells of the liver and other mesenchymal cells, the sporozoites develop into schizonts which divide asexually and form tissular merozoites. Some of them become lodged in the adjacent mesenchimal cells, where the next phase of tissular schizogony occurs. Others enter the blood stream and lodge in erythrocytes. The merozoite in the erythrocyte grows by feeding on the contents

of the erythrocyte and develops into a schizont. When the schizont has reached maximum growth it divides into several merozoites which escape from the erythrocyte, rupturing it in the process. Finding themselves in the blood stream, the merozoites enter other erythrocytes and undergo another cycle of schizogony, etc. It is schizogony in the erythrocytes, with the rupture of the latter, that is responsible for the characteristic attacks of fever with alternating periods of apyrexia.

Different forms of malaria are distinguished not only by the severity of the course of the disease and by other clinical signs, but also by the length of the incubation period and the duration of the attacks and of periods of apyrexia. In the tertian malaria of the southern areas the incubation period lasts 14 days on the average, whereas in the tertian malaria of the northern areas it may extend to several months. The reason for this is the existence of two kinds of tertian malaria parasites, one of which has become adapted to a southern environment, and the other, to northern conditions. Owing to the brief summer season the latter malaria agent succeeds in changing the host only once (man-mosquito-man). If there were a brief incubation period, the infectious stage of the disease would occur in the autumn when infection of mosquitoes is impossible. In this case, however, with an incubation period of six to eight months, a person who contracts the infection in the summer falls ill and becomes infectious the following spring, when biologically active mosquitoes are present. So, the malaria of the northern areas with a long incubation period is a result of the adaptation of the parasite to unfavourable ecological conditions, whereas in the south, where there are several succeeding generations of mosquito during the long spring, summer and early autumn, the brief incubation period has resulted from the adaptation of the parasite to more favourable ecological conditions. As for the other forms of malaria, in tropical malaria incubation is 12 days on the average, and in quartan malaria, four weeks.

Malaria attacks last from eight to ten hours, the duration of apyrexia in different forms of malaria varies, hence the names of these forms. In tropical malaria, which is the most serious form of this disease, the attacks set in daily

or every other day (*Malaria quotidiana*), schizogony continuing for 48 hours. In tertian malaria the schizogony also continues for 48 hours and the attacks occur every other day (*Malaria tertiana*). In quartan malaria schizogony lasts for 72 hours and the attacks occur every third day (*Malaria quartana*).

In three or four weeks after the commencement of attacks associated with the schizogony in the erythrocytes, there takes place the development of sexual cells from some of the merozoites which had lodged in the erythrocytes: macrogametocytes (female sexual cells) and microgametocytes (male sexual cells). Man becomes infectious for mosquitoes upon the formation of gametocytes since it is they that are responsible for the subsequent stages of the parasite's development in the body of the mosquito.

It is also characteristic of the course of malaria that series of attacks alternate with more or less prolonged remissions. Fresh series of attacks are designated as relapses. When the disease is not fatal, it terminates by auto-cure even in the absence of specific chemotherapy. Tropical malaria does not last for more than a year. Tertian malaria lasts for 18 months to two years and a quartan, three or four years. Susceptibility to malaria is universal; those who have been infected do not develop immunity and a person can therefore suffer from the same form of malaria several times. However, if there are several infections, partial immunity is developed.

Sources of Infection. The sources of infection in malaria are patients, whose period of infectivity is determined by the time of the appearance of gametocytes in the blood and by the duration of the malarial infection. Apart from patients, so-called cold parasite carriers may be sources of infection, i. e., persons who have gametocytes in their blood but do not develop the disease. They are usually patients who have had several attacks and are in the remission stage; very rarely they are healthy carriers proper.

Routes of Transmission. Malaria is transmitted by the bite of the Anopheles mosquito. More than 100 mosquitoes belonging to this genus transmit malaria from man to man. Most of them are wild species and are of little significance in malaria epidemiology. Only a few which exist

near man's dwellings (synanthropous mosquitoes) are of epidemiological importance. Mosquitoes deposit eggs in reservoirs (at times even in small ones such as water butts), where larvae hatch from them with subsequent pupation. This is followed by the emergence of adult winged mosquitoes (imago) from the pupa case. Climatic conditions influence the period of development, in the temperate zone there are three or four generations during the summer, in the northern areas there are one or two, and in the southern districts, five or six.

Female mosquitoes feed on human and animal blood, which they need to bring the eggs in the ovaries to maturity. Some of the fertilised females hibernate during the winter and deposit their eggs the following season.

When blood containing malaria plasmodia arrives in the intestinal tract of a mosquito, all asexual forms (merozoites, schizonts) die, and the sexual forms—macro- and microgametocytes are liberated from the digested erythrocytes. From these, the macrogametes are formed—the bigger formations, and the microgametes—the smaller motile flagellated forms. The fertilisation of the macrogametes by the microgametes takes place in the stomach of the mosquito, resulting in the formation of a motile zygote—oökinete; this penetrates the stomach wall and develops into an oöcyst, within which a tremendous number of sporozoites mature. The sporozoites rupture the envelope of the oöcyst and penetrate the salivary glands of the mosquito. The entire cycle of sporogony takes from seven to 45 days, depending on the temperature of the environment which, however, must not be under 16°C.

Epidemiology. Malaria is one of the most widespread diseases in the world. At present it affects tens and hundreds of millions of people. The greatest foci of malaria (mainly of tropical malaria) are in Africa, South-East Asia, Oceania, and Latin America. During the past decade most European countries, the North American countries and Australia have largely or completely suppressed malaria.

Malaria was extremely widespread in Russia before the Revolution. According to very incomplete statistics (for Central Asia and the Caucasus) 3.4 million cases were registered in 1913. A systematic campaign against malaria was

started under Soviet power. Already on the eve of the war the malaria morbidity rate had dropped considerably, though remaining high (3,176,527 cases in 1940). During the war, malaria morbidity increased, particularly in the areas occupied by the Germans. After the war malaria morbidity has been steadily and rapidly decreasing. Thus, while 3,364,502 patients were registered in 1946, the number had dropped to 721,329 by 1950 and there were only 35,704 patients in 1955. In 1959 malaria was practically eradicated throughout the country, there were less than 1,500 cases registered, and these were confined to a few districts, mainly Azerbaijan, the Central Asian Republics and some parts of Siberia. Malaria was finally eradicated in the U.S.S.R. in 1960.

Laboratory Diagnosis. Laboratory diagnosis of malaria is based on the microscopic study of smears and thick blood drops.

Prophylaxis. Malaria prophylaxis aims at terminating the infectivity of patients and the destruction of infected vectors, and also includes additional measures of mosquito control at different stages of its development and in some cases the use of chemoprophylaxis.

Parasite carriers in malarial areas are registered when applying for medical assistance and are also discovered by clinical examination (detection of persons with enlargement of the spleen) and by laboratory tests (blood examination for parasite carrying). All malaria patients or those in whose blood malarial parasites have been detected should be registered and given current and anti-relapse treatment, and in each case the district sanitary-epidemiological station should be immediately notified. In addition to former means of chemotherapy (quinacrine, quinine) and gametocide (plasmocide) there are more effective preparations in current use: bigumal and quinocide. When the epidemiological situation is very dangerous anti-malaria preparations are issued to persons exposed to infection.

The most effective means of suppressing malaria vectors are contact insecticides used in the foci—DDT preparations and hexachlorocyclohexane. These preparations are sprayed over the internal and external walls of dwellings, other structures and objects close to them. This guarantees the destruction

of infected mosquitoes, since the engorged females of malarial mosquitoes do not fly away but remain in resting-places during the day in shady premises free from draughts (they attack man and animals at night). This type of treatment is particularly effective since it ensures the destruction of infected mosquitoes.

Other measures of vector control include mechanical protection by screening walls, blocking doors, using bed curtains (this measure is obligatory when malarial patients are involved, to guard against the infection of mosquitoes), and various other measures for exterminating mosquitoes in the dwellings (flypaper, flappers, aerosol tanks) and repellents.

Zoological prophylaxis is also used, cattle being left to graze between the mosquito breeding-place and human habitation, so that the *Anopheles* should attack cattle rather than man.

Prior to the development of contact insecticides of the DDT type, measures were taken to destroy mosquito larvae, and they are also used today when the aim is not merely to combat malaria but to destroy mosquitoes and gnats in general. These measures include the treatment of reservoirs with contact and intestinal insecticides, controlled irrigation, as a result of which the larvae perish prior to hatching, the breeding of water fowl and gambusia fish which devour the larvae, etc. Owing to the high cost of these measures they are replaced by the use of contact insecticides of the DDT type.

SANDFLY FEVER (PAPPATACI FEVER)

Etiology. The agent of pappataci or sandfly fever is a filtrable virus. The virus of Pappataci fever has poor resistance in the environment. Kept at room temperature in blood serum it survives for three to five days, but when dried in a vacuum or frozen, its viability lasts for several years. The virus is cultivated in chick embryos or in tissue cultures, which is important for the manufacture of vaccines.

Pathogenesis. The incubation period in pappataci fever lasts on the average from three to five days. The disease takes an acute course, with a high fever, a marked pain syndrome and hyperemia of the skin and the mucous membranes. The body temperature remains high for two or three days and then drops to the critical. These features of the clinical picture in pappataci fever reflect the pathogenesis of the disease. The virus enters the organism with a bite by an infected mosquito, it multiplies rapidly in the blood and gives rise to a vigorous reaction in the organism. Though the course of the disease is always benign, after the drop of the temperature the patient suffers from adynamia and feebleness for one or two weeks and recuperates slowly.

Sources of Infection. There are grounds for believing that pappataci fever is a natural foci disease. The reservoir of the virus in nature are small mouse-like rodents. At the same time, in communities, pappataci fever is an anthroponosis, the virus being transmitted from man to man by mosquitoes.

The CFT (complement fixation test) in sandfly fever has shown that strongly positive reactions can be obtained

in endemic foci when testing sera withdrawn from rats and dogs belonging to the same locality. Several strains of the virus have been isolated from the blood of rats obtained in such foci.

Routes of Transmission. Man is infected with pappataci fever virus through a bite by an infected female sandfly *Phlebotomus pappatasii*, though there are indications that the infection can also be transmitted by other species of mosquitoes. The insects obtain the virus from the blood of patients. In natural conditions the virus is preserved in the organism of female mosquitoes for a brief period; during the winter period it is preserved in mosquito larvae.

The virus of pappataci fever is sometimes passed on to the first and even to the second generation of mosquitoes. Therefore, it appears likely that mosquitoes not only transmit the infection to man but can also serve as a natural reservoir of the virus.

Epidemiology. Pappataci fever is widespread in the Mediterranean area, in Iran, India, West and East Africa, Latin America, Australia and in other tropical and subtropical areas. In the U.S.S.R. it is found in Central Asia and in the Caucasus. Formerly it was widespread in the Crimea and in Ashkhabad, but in the past decade it has been practically eradicated in these areas.

Pappataci fever is a seasonal disease. Epidemics begin after the mass emergence of mosquitoes (May-June) and end with the disappearance of the mosquitoes (September-October). The morbidity peak is in July-August.

Most cases involve exogenous population of all ages. The local residents are usually affected by the infection in childhood and develop immunity, though in pappataci fever it is relative immunity: in one season a person may have the disease twice and even three times. Up to 20 per cent of all cases during a season are reinfections.

Laboratory Diagnosis. The diagnosis of pappataci fever is made by isolating the virus or by registering an antibody rise in the blood. However, since this method is complicated and since the course of the disease is mild, laboratory tests are seldom resorted to.

Prophylaxis. Prophylaxis of pappataci fever includes the following measures: a) the destruction of the vectors;

b) control of the reservoir of infection and c) the development of stable immunity in the population.

The experience of controlling pappataci fever by acting upon the vector has fully justified itself. Destruction of vectors results in the eradication of big endemic foci. The mass destruction of winged mosquitoes is particularly important in the struggle against pappataci fever within an endemic focus. A big part is also played by the timely isolation of patients and disinfestation of premises, as well as the use of repellents in the evenings and at night. The largest possible number of premises should be treated with insecticides, including stables, cattle sheds and barns. Medical institutions, in particular wards for pappataci fever patients, should be the first to be treated with insecticides. The insecticides used are DDT and hexachlorocyclohexane.

In the evening and during the night it is advisable to use in the open Pavlovsky's netting impregnated with repellents (tar, lysol, etc.). It is also advisable to smear exposed parts of the body with dimethylphthalate, an aqueous solution of anabasine sulfate or other repellents.

Inoculation with live dry vaccine made of virus strains adapted to the white mice organism with subsequent multiplication on chick embryos, as suggested by S. A. Ananyan, is a means of developing active immunity against pappataci fever. Inoculation is carried out epicutaneously and subcutaneously. Double inoculation with a monthly interval enhances the potency of live vaccine. The inoculations should be made 40-60 days and re-inoculation 20-25 days in advance of the epidemic season. Non-immune arrivals in the endemic focus may be immunised at an accelerated rate—in three doses at two-day intervals. It is particularly important to inoculate big groups of people arriving from places where pappataci fever is non-existent.

LEISHMANIASIS

Leishmaniasis is a term used to describe a big group of infections caused by pathogenic protozoans—leishmaniae. According to the clinical course of the disease we differentiate between cutaneous and visceral leishmaniasis. Most leishmaniases are natural foci diseases. The reservoir of the agent is wild rodents, and the vector is the *Phlebotomus* mosquito. In the course of the evolution of leishmaniasis and the adaptation of its vectors to life close to man's dwellings, some forms have become anthroponoses (cutaneous leishmaniasis [urban type], and Indian visceral leishmaniasis kala-azar), while others are zoonoses affecting man and domestic animals (visceral leishmaniasis in the U.S.S.R.). The world distribution of leishmaniasis infections is shown in Fig. 58. Leishmaniasis has been studied in the U.S.S.R. by P. F. Borovsky, N. I. Latyshev, P. V. Kozhevnikov and others.

Cutaneous Leishmaniasis (Urban Type). The causative agent of this leishmaniasis is *Leishmania tropica minor.* The disease develops after a long incubation period lasting on the average for about eight months and first manifests itself as a papule at the site of the bite. This papule slowly develops and ulcerates in eight or ten months (hence one of the names of the disease—leishmaniasis of late ulceration; other commonly used names include Ashkhabadka, one-year disease). The disease lasts for 18 months to two years and eventually heals with scarring. Recovery is accompanied by the development of life-long immunity.

Man is the host reservoir of the agent and is infectious during the development of papules and ulcers at the points

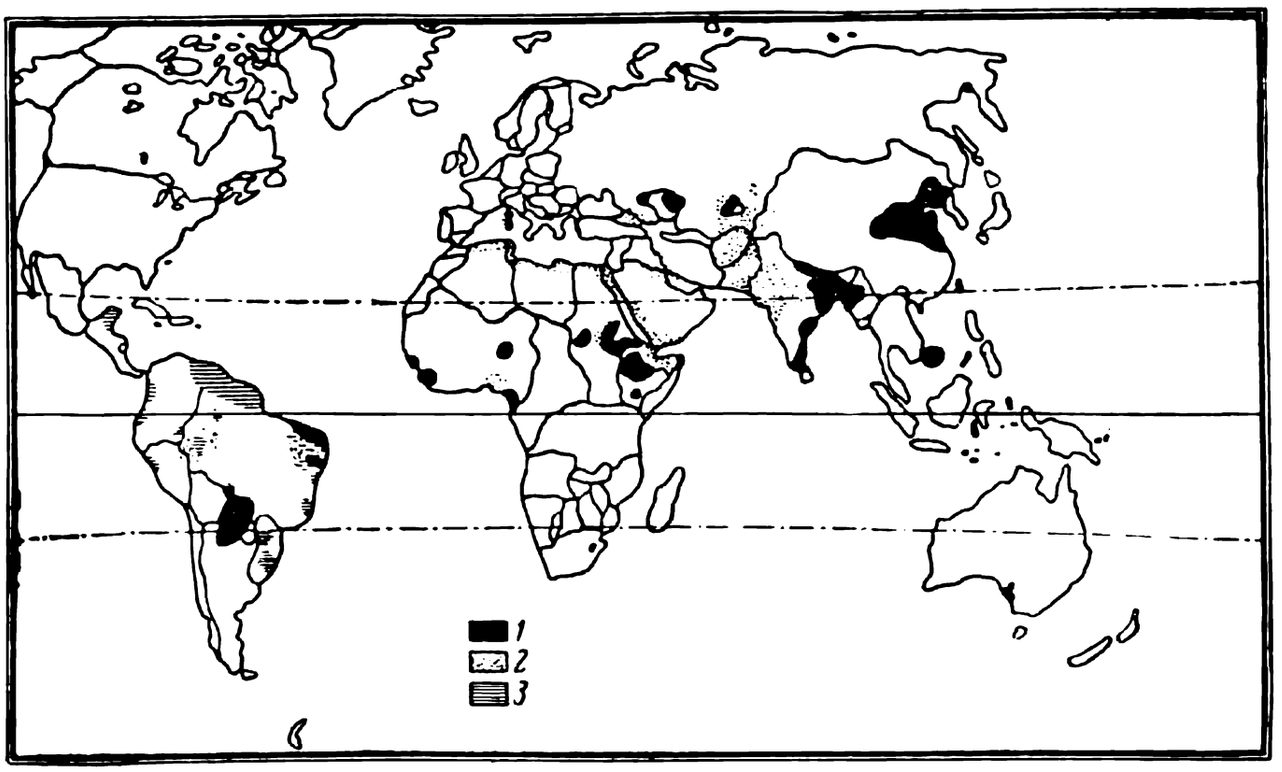


Fig. 58. Distribution of leishmaniases in the world (after K. Raška)

1—visceral leishmaniasis; *2*—cutaneous leishmaniasis; *3*—nasopharyngeal leishmaniasis

where leishmaniae lodge themselves and multiply. The vector is a mosquito—*Phlebotomus pappatasii.* Infection occurs in the warm months of the year when the mosquitoes are active.

Cutaneous leishmaniasis (urban type) is observed in towns in Central Asia, Southern Europe, North Africa and India.

Laboratory diagnosis is established by microscopy of ulcer smears and punctates drawn from the papules.

Prophylaxis consists in the systematic extermination of mosquitoes and the protection of affected skin areas of patients from bites. Repellents are also used. Prophylactic inoculations of leishmania cultures are carried out in areas affected by leishmaniasis.

Cutaneous Leishmaniasis (Rural Type). The agent is similar to the previous species of leishmania—*Leishmania tropica major.* The disease develops following a brief incubation period ranging from one week to two months. Furuncular infiltrates develop at the site of the bite and ulcerate rapidly (hence, one of the names of the disease—

acute-necrotising leishmaniasis). Ordinarily, regional lymphadenitis develops. In two to four months scarring occurs with healing. Immunity is life-long.

The reservoir of the pathogen is found in gebrils *Rhombomys opimus* inhabiting desert areas of Central Asia. The same form of leishmaniasis is found in Arabia and North Africa. The vector is the *Phlebotomus pappatasii* mosquito and other representatives of this genus. The foci of cutaneous leishmaniasis (rural type) can be considerable and even a brief stay in them may result in mass infection, with the development of many ulcers in each patient

Laboratory diagnosis is made by microscopic examination of the content of ulcers or punctates.

Prophylaxis is based on the extermination of mosquitoes and protection against their attacks. Within a 1.5 km range of communities rodents, in whose burrows mosquitoes live and hatch out, are destroyed, usually by gassing. The screening of windows, blocking of doors, use of bed curtains and repellents are means of defence against mosquitoes. Prophylactic inoculation with leishmania cultures is also carried out on the forearm or hip, and the resulting immunity lasts for a period of six months to a year. Vaccination is done in the autumn so as to develop immunity by spring time.

Visceral Leishmaniasis. The agent of this form of leishmaniasis is *Leishmania donovani.* After entering the human organism through the bite of an infected mosquito, the leishmaniae are carried through the organism by the blood stream and settle in the liver, the spleen, in some other organs and in the marrow. They develop in the cells of the histophagocytic system. Following an incubation period which ranges from several weeks to several months, fever sets in, the liver and spleen become enlarged, anemia and emaciation develop. When no special treatment is given, the disease leads to cachexia and death. Convalescents develop life-long immunity.

The reservoirs of the agent are patients, dogs and jackals. The disease is transmitted by the bites of mosquitoes, *Phlebotomus chinensis*, *Phlebotomus kandelaki* and other representatives of this genus.

Visceral leishmaniasis is widespread in India, China, Central Africa and the Mediterranean area, and it is possible that the forms of visceral leishmaniasis found in these areas are non-identical.

Laboratory diagnosis is made by microscopic study of spleen and marrow punctates.

Prophylaxis is similar to that in the case of cutaneous leishmaniasis. In addition to the measures described, stray dogs, and jackals should be destroyed, and pet dogs should be examined. Infected animals should be killed, but if they are valuable, specific treatment can be applied. Inoculation is not carried out in this type of leishmaniasis.

PLAGUE

Etiology. The agent of plague (*Pasteurella pestis*) belongs to the group of a hemorrhagic septicemic bacteria which includes the tularemia and pasteurellosis bacteria. Despite the vast area over which it is to be found, the plague microbe is distinguished by stability of biological properties; the difference between the known varieties (the so-called oceanic and continental strains) is slight and from the immunological point of view they are identical.

The resistance of the plague microbe to environmental influences is comparatively poor. It perishes rapidly upon exposure to direct sunlight, when heated to 60°C and when treated by disinfectants in standard concentrations. It perishes within a few days in excreta and carcasses of animals during summer under the influence of putrefactive flora. In winter it can remain viable in frozen carcasses until the spring.

Pathogenesis. The pathogenesis of plague infection depends to a great extent upon the portal of entry. When infection occurs through the skin (a flea bite or penetration through skin abrasions) regional lymphadenitis develops with a pronounced enlargement of the lymph node due to acute necrotic inflammation (pestilential bubo) and bacteriemia. The latter can be accompanied by the development of secondary hemorrhagic pneumonia. When the portal of entry is the respiratory tract, primary hemorrhagic pneumonia and sepsis take place. If entry is effected through the gastro-intestinal tract, there is hemorrhagic enteritis and sepsis. Neglected plague gives rise to hemorrhagic sepsis and results in death. In bubonic plague mortal-

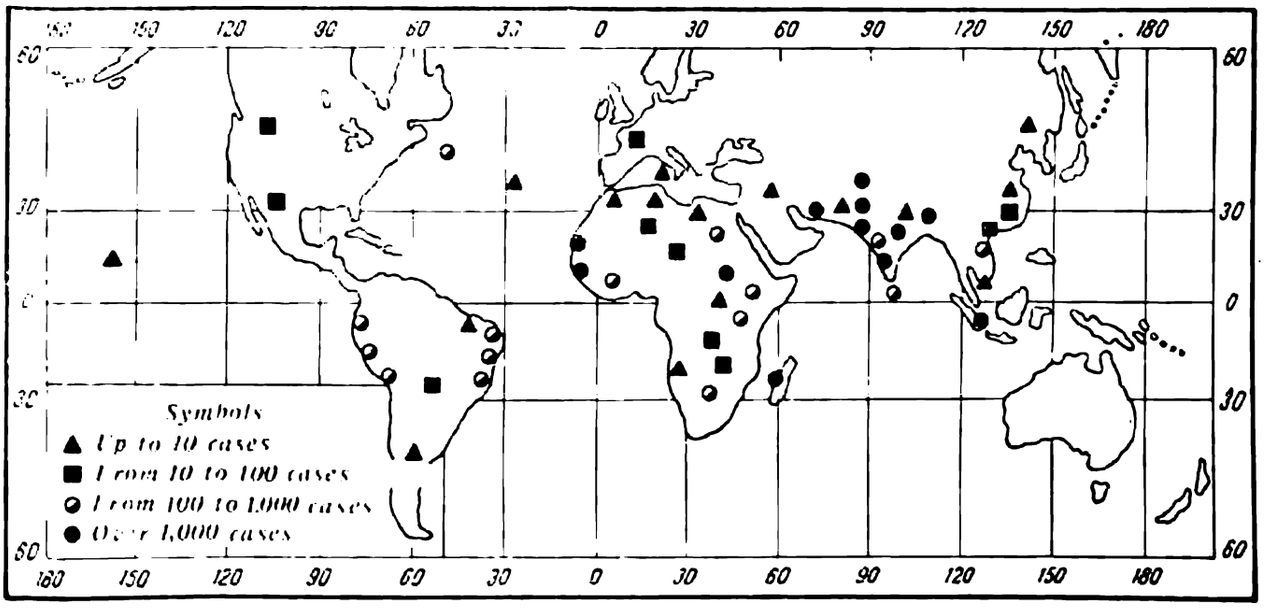


Fig. 59. World plague epidemics from 1934 to 1945 (after V. N. Fyodorov and I. I. Rogozin)

ity used to reach 70 per cent, and in pulmonary and intestinal plague, 100 per cent. Today, thanks to the use of streptomycin, colimycin (an antibiotic of the neomycin group) and other antibiotics, plague can be cured if the drugs are used at an early stage.

The incubation period is no more than six days, usually it is less. The patient becomes infectious only in pulmonary and intestinal forms of plague. The infection is accompanied by the development of life-long immunity.

Sources of Infection. Plague is a natural foci infection with foci in Europe, Asia, Africa and America within the broad belt from 35-40° North to 35-40° South, mainly in desert and semidesert zones and in mountainous areas (Fig. 59). The natural reservoir of the infection is found in many species of rodents which may be primary or secondary host reservoirs.

The basic natural reservoir of plague infection is found in gebrils, marmots and gophers; the vectors are fleas which parasitise on those rodents. In some countries (India, Indonesia and others) rats may be involved in the epizootic process and then enzootic plague foci originate in communities. The rats and the fleas parasitic on them (the rat flea *Xenopsylla cheopis*, the human flea *Pullex irritans*) can bring plague to port towns remote from primary natural foci.

Routes of Transmission. Man is infected with plague in natural foci through the bite of an infected flea or in the course of hunting marmots and handling infected animals. Camels which become infected in natural foci are also of certain epidemiological significance: cases are known of people becoming infected with plague after eating meat of sick camels. In hot countries and in the port towns of the subtropical zone people are sometimes infected in the foci of rat plague, also through bites from fleas. Pulmonary plague can be transmitted from man to man by the droplet method.

Epidemiology. In the past, plague epidemics were very widespread and took toll of tens of millions of lives (Europe, 14th-15th centuries). Today plague is found in India and in neighbouring countries, in Central Africa and South America, though the use of anti-epidemic measures and of antibiotics has reduced morbidity and mortality radically.

Laboratory Diagnosis. Laboratory diagnosis of plague is made by microscopic study and by culture growth of sputum smears, punctates from buboes and carcass material. Stringent safety measures should be observed when handling suspect material, which should be packed in glass containers with ground-in stoppers. The containers should be wrapped in cloth impregnated with disinfectants and placed in air-tight cases.

Prophylaxis. Prophylaxis is based on broad measures for the suppression of natural foci of this disease, quarantine and anti-epidemic measures, and prophylactic vaccination.

A network of anti-plague institutions has been set up in the U.S.S.R. It includes plague research institutes, anti-plague centres and laboratories. These institutions conduct annual surveys of natural foci of plague to detect and suppress epizootics. Rodents and ectoparasites are exterminated, particularly when the foci are close to inhabited places. As a precaution, rodents are exterminated in communities and port towns. A live vaccine made of avirulent strains of plague bacteria is used for inoculating people living in areas close to natural foci. Inoculation is done subcutaneously (one ml of vacuum-dehydrated

vaccine diluted as specified on the label is administered) or intracutaneously (0.1 ml of a stronger concentration).

A plague suspect should be isolated immediately in a separate cubicle, and the appropriate authorities notified who, in their turn, immediately inform the higher public health bodies. The staff of a plague hospital should wear special anti-plague suits and cotton-and-gauze masks, since the risk of infection is very great (Fig. 60). Thorough decontamination of a patient's excreta and of the anti-plague suits of the staff is imperative. All contacts are subject to nine days' isolation and quarantine. During this period they are kept under medical observation and are given a course of prophylactic chemotherapy with antibiotics (streptomycin, colimycin). All objects of little value at the seat of infection from which the patient has been taken are burnt, all other objects are subject to chamber disinfection while the premises are disinfected by washing and fumigation (the latter is done to destroy rodents and ectoparasites). The corpses of plague victims are covered with chloride of lime or some other disinfectant and buried underground at a depth of at least 1.5-2 m.

Fig. 60. General view of modern anti-plague suits (after V. N. Fyodorov and I. I. Rogozin)

Plague is a quarantine infection and measures to combat it are conducted on an international scale. They include the urgent notification of cases, quarantine regulations for vessels arriving from places affected by plague and the destruction of rats and insects.

TULAREMIA

Etiology. The agent of tularemia (*Pasteurella tularensis*), like the plague bacteria, belongs to the groups of hemorrhagic septicemia bacilli. The tularemia bacillus is rather stable in environment, it remains viable in damp soil for more than a month, in water up to three months, in dried grain for more than four months, in salted meat for more than a month, in milk until it turns sour, etc. The tularemia bacillus, however, is unstable under the action of disinfectants and heating like other vegetative forms of bacteria.

Pathogenesis. The microbe can enter man's organism by several routes: through the skin (abrasions or bites by infected vectors), by the gastro-intestinal tract and the respiratory tract. Once in the organism, they settle in the regional lymph nodes and cause inflammation (buboes); subsequently they spread in the organism through the blood stream, causing a general febrile reaction and the development of foci in the organs.

Several phases are distinguished in the pathogenesis of tularemia: adaptation of the microbe (incubation), protective reactions of the organism, bacteremia, focal lesions and recuperation. The forms of tularemia depend on the site of implantation of the agent.

When entry is through the skin, bubonic or ulcerous-bubonic forms result; when infection occurs through the mucous membranes of the eye, there is necrotic conjunctivitis with lesions of the parotid and precervical lymph nodes; infection through the pharynx results in angina with lesions of the cervical and submaxillary lymph nodes.

Tularemic pneumonia or broncho-adenitis result from entry through the respiratory tract. In the case of alimentary

infection lymphadenitis of the mesenterial glands sets in. Septicemia develops in all forms of tularemia, particularly in the pulmonary and abdominal forms.

The incubation period varies from two to eight days. Infection is accompanied by the development of life-long immunity. Tularemia patients are not infectious to their contacts.

Sources of Infection. Tularemia is a zoonosis with natural foci and complex circulation of the agent. In different countries many species of animals, rodents in particular, are natural reservoirs of the agent. They are infected by excreta, water, food or by blood-sucking arthropoda.

The main reservoirs of tularemia infection in the U.S.S.R. are water voles (*Arvicola amphibium*), small mouse-like rodents (voles and house mice), hares, insectivora (shrews). The most persistent foci of tularemia are in flood areas inhabited by water-loving rodents. A considerable increase in the number of small rodents in the fields and meadows can give rise to epizootics with a resultant spread of infection to people.

Routes of Transmission. Man contracts the infection in a number of ways as a result of which different types of tularemia epidemics are distinguished (as classified by I. N. Maisky).

a) *Occupational epidemics* are observed among water-vole and hare trappers; infection occurs either as a result of bites by animal ectoparasites (fleas or ticks), the handling of infected carcasses, or contamination of mouth or eyes by infected hands. The clinical forms are ulcerous-bubonic, ophthalmic and anginous.

b) *Water-borne epidemics* occur as a result of bathing in infected reservoirs or drinking infected water. The portal of entry is skin abrasions, the mucous membranes of the eye, and the pharynx. The forms of the disease are the same; there are also intestinal (abdominal) forms.

c) *Transmissive epidemics* are observed when infection occurs through the bite of diptera (horse-flies, biting flies); it is common among people engaged in farm work (haymaking, reaping) in enzootic foci. In this case ulcerous-bubonic forms of tularemia with ulceration on the exposed parts of the body occur, involving regional lymph nodes.

d) *Epidemics associated with mouse-like rodents* occur when these animals infest grain stacks left in the fields. People become infected during grain-threshing. In this case it is a question of the dust-borne method of infection. The common forms are pulmonary and bronchopulmonary; the abdominal and septic forms are less frequent.

e) *Domestic epidemics* occur when mice migrate from fields to dwellings. The mechanisms of transmission vary; the alimentary mechanism is common, giving rise to the abdominal and the pulmonary forms of tularemia. Epizootics involving cats, whose urine and carcasses can infect water sources (wells), also have some importance in populated areas.

f) *Trench outbreaks of tularemia* occur when the trenches are inhabited by mouse-like rodents. Methods of transmission and forms of the disease are similar to those in domestic outbreaks of tularemia.

Epidemiology. Only outbreaks of tularemia associated with mouse-like rodents are likely to spread over a vast area. Other outbreaks are, as a rule, limited.

Natural foci of tularemia are found in large areas of the U.S.S.R. (Fig. 61), but the intensity of tularemia epizootics

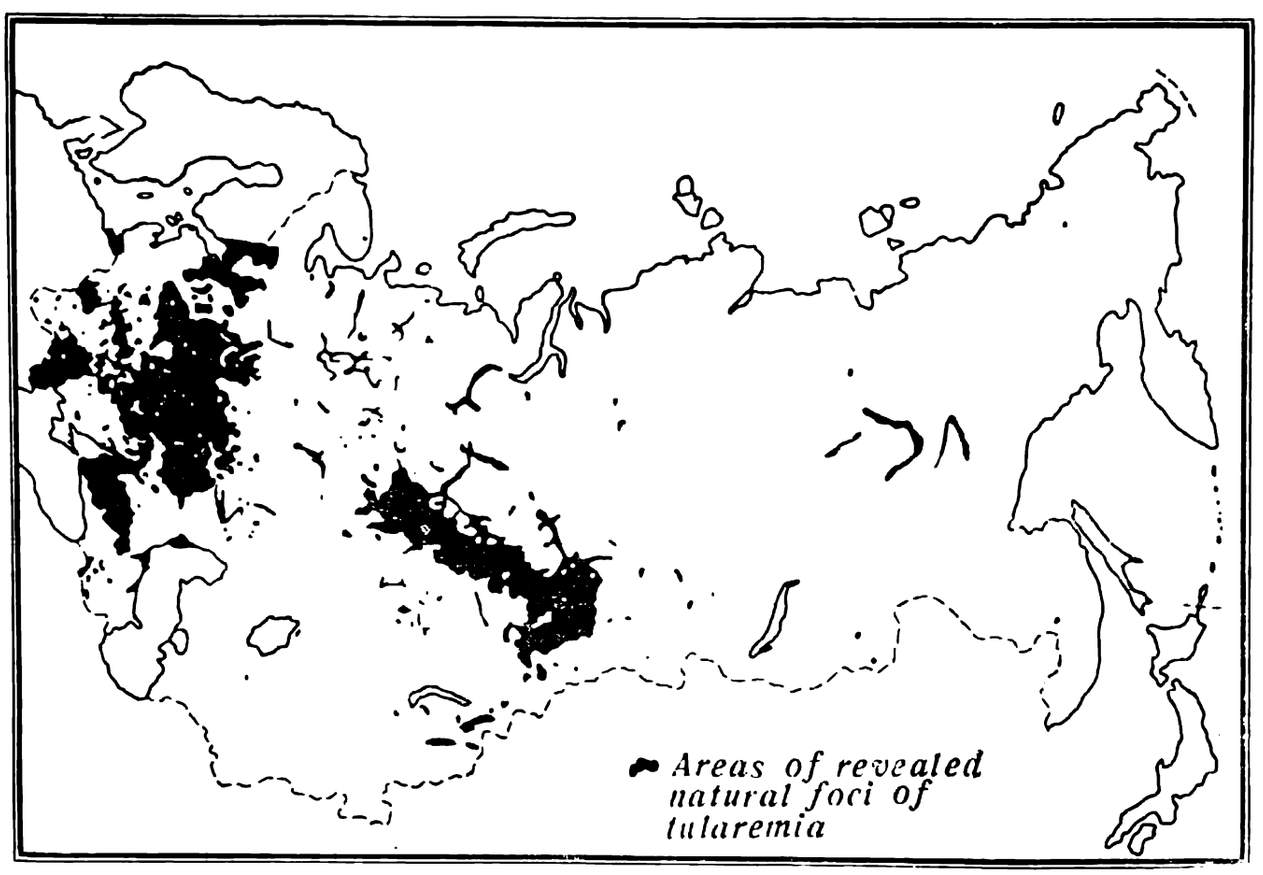


Fig. 61. Natural foci of tularemia in the U.S.S.R. (after N. G. Olsufyev)

in these foci has been considerably suppressed—a result of scientific farming and also of specific rodent control measures which have led to a reduction in the rodent population in the fields.

Tularemia morbidity was high in the U.S.S.R. during the war and in the immediate post-war years when considerable outbreaks occurred, because many grain stacks had been left in the fields and were inhabited by mouse-like rodents. Subsequently tularemia morbidity radically decreased and now remains at a low level (Fig. 62).

Laboratory Diagnosis. Laboratory diagnosis of tularemia is made by isolating the microbe and by serological tests with convalescent blood sera. Intracutaneous and epicutaneous allergy tests are used to determine the immune stratum of the population.

Fig. 62. Drop in tularemia morbidity in the U.S.S.R.

Prophylaxis. Prophylaxis of tularemia is based on scientific farming and on specific measures to exterminate rodents. Whenever grain is left in the field, trap ditches should be made to protect the stacks against rodents. Anti-epidemic measures vary with the type of epidemics.

Persons exposed to tularemia are inoculated. These include water-vole and hare trappers, field workers, etc.

The vaccine is made from live attenuated tularemia bacteria (Gaisky-Elbert vaccine) and is applied epicutaneously. The inoculation procedure is the same as for smallpox.

Anti-tularemia inoculation helps to develop immunity which practically excludes the possibility of infection.

All the rural population and certain groups of the urban population (hunters, trappers, etc.) should, therefore, be covered by vaccination programmes in enzootic areas. Regular selective testing of the population with tularemia allergen makes possible the determination of the proportion represented by the immune stratum.

Though tularemia patients are not infectious to other people they are placed in hospitals for a course of specific treatment, and the local sanitary-epidemiological station is notified.

TICK-BORNE ENCEPHALITIS

(RUSSIAN TICK-BORNE SPRING-SUMMER ENCEPHALITIS)

Etiology. The agent of tick-borne encephalitis is one of the smaller viruses. It is unstable and easily destroyed by disinfectants in standard concentrations, but can remain viable for several years in a 50 per cent glycerine solution or when dried in a vacuum and preserved at a low temperature. Many wild animals, mice and monkeys are susceptible to the virus of tick-borne encephalitis, in many cases developing the asymptomatic form of the infection. The strains of the virus isolated in different areas differ in certain biological properties but have a similar antigenic structure and cross immunity.

Tick-borne encephalitis was discovered in the U.S.S.R. in 1938 and was studied by L. A. Zilber, M. P. Chumakov, V. D. Solovyov, Y. N. Levkovich and others.

Pathogenesis. The agent enters the blood stream usually as a result of the bite of an infected tick (in other mechanisms of infection which we shall discuss further on, the virus also eventually enters the blood stream) and spreads throughout the organism. The virus finds the most favourable conditions for its multiplication in the central nervous system where it affects the anterior-spinal crescent and the nuclei of the brain stem. In typical cases, pathologo-anatomic analysis established the diagnosis of meningo-encephalopoliomyelitis. Viremia is present during the acute phase of the disease: the virus can be isolated from the blood and from the spinal fluid. The virus is not discharged into the environment.

Clinically tick-borne encephalitis takes the course of a severe acute infectious disease. It develops following an incubation period of one to three weeks (most commonly 10 to 14 days), commencing with acute fever, meningeal symptom and excitation of the nervous system. Subsequently, various disorders of the sensory and motor spheres ensue. In grave cases the patient dies in the comatose state. Atrophic paralysis of the cervical and shoulder muscles may develop during convalescence. There are no after-effects in mild cases and recovery is accompanied by the development of a life-long immunity.

Sources of Infection. Tick-borne encephalitis is a zoonosis with natural foci. The reservoir of the virus is various species of small rodents and other animals inhabiting wooded localities: chipmunks, hedgehogs, moles and voles, from which the virus of tick-borne encephalitis has been isolated. The reservoirs also include Caraco rats and birds—linnets, buntings, thrushes and others. Thus, a large number of forest animals and birds may form the reservoir of the infection, maintaining the circulation of the tick-borne encephalitis virus in the natural foci.

Routes of Transmission. The vectors of the virus are *Ixodes* ticks. The *Ixodes persulcatus* in the eastern areas of the U.S.S.R. and *Ixodes ricinus* in the western areas of the country are particularly important. Ticks parasitic on the above-mentioned species of animals attack them periodically and feed on their blood. During their development from the larval stage to the nymph stage and then into an adult tick, these species of ticks feed three times, once in every phase and each time on a new host. Ticks become infected when sucking the blood of diseased animals. The virus penetrates all the tissues of the body, multiplies, and arrives in the salivary glands. When the infected tick sucks the blood of a healthy animal, the virus enters the bite wound and infection occurs. The infected female ticks can transmit the virus via their eggs to future generations. So while being the vectors of encephalitis, the ticks are at the same time the reservoirs of this infection. As a result, the circulation of the tick-borne encephalitis virus in nature is complex and varied.

Domestic animals, goats, cows, sheep, may be involved

in the circulation of the virus in populated areas. Most likely the Scottish encephalitis of sheep (loping ill) in Britain and the biphasic meningo-encephalitis (milk fever) found in the U.S.S.R., Czechoslovakia and in other countries are either identical with tick-borne encephalitis or are variants of it.

Thus, man contracts tick-borne encephalitis in natural foci as a result of a bite by an infected tick, and in some foci through drinking the milk of cows and goats infected by ticks. There are indications that in addition to the clinically manifested forms, tick-borne encephalitis in man may also take the asymptomatic form, also leading to the development of lasting post-infectional immunity. Probably this explains why the incidence of this infection in the indigenous population of areas afflicted with tick-borne encephalitis is much lower than in newcomers. Blood sera examinations of the local population sometimes reveals virus-neutralising antibodies, though the case histories contain no mention of tick-borne encephalitis.

Spring-summer tick-borne encephalitis and its varieties

Scotland encephalitis of sheep (loping ill)

Fig. 63. Distribution of tick-borne encephalitides in the U.S.S.R. (after O. V. Baroyan)

Epidemiology. Tick-borne encephalitis is found in the U.S.S.R., in many European countries (Czechoslovakia, Poland, Bulgaria, the German Democratic Republic, Hungary, Yugoslavia) and recently has been discovered in India and in the Malay Peninsula (Fig. 63). Cases of the disease occur in wooded, agricultural and certain suburban areas. Frequently the disease acquires an occupational nature affecting timber workers, prospectors and trappers, but it may also be found among town residents who visit forests.

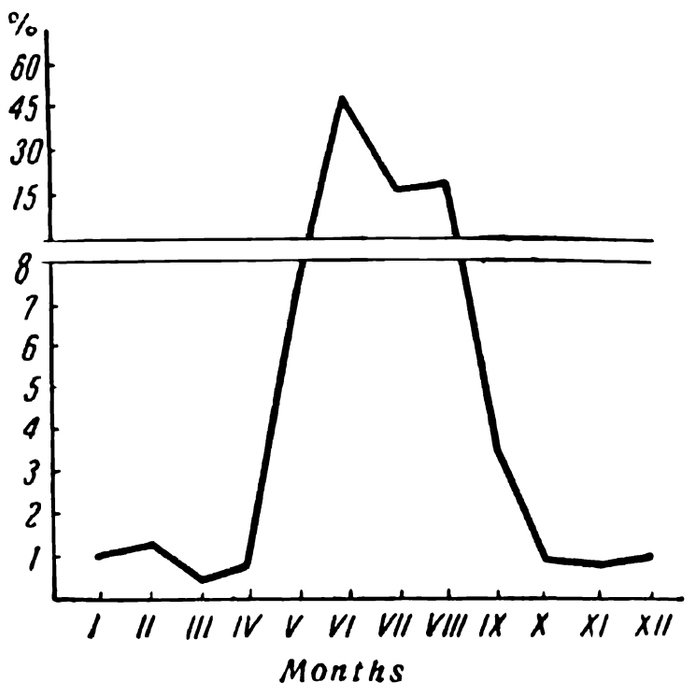


Fig. 64. Seasonal distribution of tick-borne encephalitis morbidity (percentages to annual total)

Outbreaks have been observed at children's summer camps situated in the natural foci of tick-borne encephalitis. Bi-phasic meningo-encephalitis has been found in suburban areas, mainly among people who spend the summer season in country cottages.

The morbidity of tick-borne encephalitis is of a strictly seasonal nature (Fig. 64) which explains one of the names of this disease (spring-summer encephalitis). As a rule cases start to appear in late April or in early May, the incidence reaching its peak by the end of May or early July and terminating in late July or early August. This pattern of seasonal distribution is governed entirely by the period of tick activity. During the period of activity, the ticks concentrate in the forests along paths frequented by animals and men, they keep to the upper parts of shrubs and attach themselves to passing animals and people. The ticks attack both during the day and at night.

Diagnosis. Diagnosis is not difficult since the symptoms are quite specific. Epidemiological survey is also simple and traces the disease either to work or to visits to the woods (hunting, mushroom-picking, etc.). The possibility

of becoming infected by milk in certain areas should not be overlooked.

Laboratory diagnosis is carried out by isolating the virus from the spinal fluid of patients or by detecting virus-neutralising bodies in convalescent sera.

Prophylaxis. Prophylaxis and suppression of tick-borne encephalitis is based on the destruction of ticks and protection against their attacks. Active immunisation is also carried out.

The patients are not infectious and hospitalisation is therefore decided on clinical, not epidemiological grounds. The district sanitary-epidemiological station is notified of every case of tick-borne encephalitis. A specific serum is widely used in the therapy of tick-borne encephalitis and it should be given as early as possible to offset grave lesions of the nervous system.

Extermination of ticks by spraying DDT preparations in foci close to populated places or in the area of sanatoriums, holiday homes or children's summer camps is a regular practice. The best results are obtained when helicopters are used for the purpose (Fig. 65).

When people are working in undeveloped areas (timbering, trapping, geological prospecting, etc.) the main prophylactic measure is protection against attacks of ticks. People working in those areas should wear protective clothing: tick-proof overalls with a zip up the front or a double row of buttons. Rubber bands are used to close the ends of sleeves and trouser legs, and the latter should also be tucked into boots. A hood should be worn on the head, leaving the face uncovered. When tick-proof overalls are not available, the ordinary clothes should be tucked in carefully and should be impregnated with repellents, dimethylphthalate, for instance.

The wearing of Y. N. Pavlovsky's netting impregnated with repellents is also advisable to prevent ticks from attacking the body at the neck opening. When work is in progress in the taiga, routine examination for ticks should be made, once during the lunch break and once after work, to remove ticks from the body or clothing. When people are camping in the forest, the sleeping area should either be cleared of brush or burned and treated

Fig. 65. Air-borne dust treatment (DDT) of a tick-borne encephalitis focus (after V. A. Nabokov)

with a ten per cent solution of lysol. Destruction of ticks found on domestic animals is also advisable.

Active immunisation with formalised vaccine is another means of prophylaxis of tick-borne encephalitis. This vaccine (developed by M. P. Chumakov, A. A. Smorodintsev, Y. N. Levkovich, A. K. Shubladze) is made from the virus of tick-borne encephalitis passed through chick embryos or tissue cultures. Inoculation is performed annually in January-March on people whose work takes them to wooded areas where there are foci of tick-borne encephalitis. The vaccine is administered subcutaneously in two doses of two and three ml with an interval of 10-15 days.

To prevent infection with milk the latter should be boiled. In the foci of biphasic meningo-encephalitis, inoculation of domestic animals is also advisable.

JAPANESE ENCEPHALITIS

Etiology. The agent of Japanese encephalitis is a filtrable virus. The virus is unstable in environment and is preserved in the organism of warm-blooded hosts and vectors. The susceptible animals are monkeys, white mice, several small rodents—mice (*Mycromys minutus*), voles (*Microtys fortis pelliceus*), hamsters (*Cricetus cricetus*), sheep and goats. Strains of the virus isolated in different areas (U.S.S.R., Japan, Korea) have identical biological properties and similar antigenic structure.

Japanese encephalitis in the U.S.S.R. was discovered and studied by A. A. Smorodintsev, Y. N. Levkovich, A. K. Shubladze and others.

Pathogenesis. The agent enters man's organs as a result of a bite by a vector and spreads with the blood stream. Since the virus is neurotropic it multiplies mainly in the central nervous system. The incubation period varies from four to 14 days. The affection of the central nervous system is characterised as pan-meningo-encephalomyelitis with pronounced involvement of the brain stem and the basal ganglia. During the acute phase of the disease the virus may be isolated from the blood and the spinal fluid, and also from the urine. However, it accumulates mainly in the brain tissue. With recovery the virus is destroyed by the action of immunological factors. The resultant immunity is lasting and repeated infections are extremely rare.

Japanese encephalitis is a severe disease with high mortality. Thus, during the epidemic of 1924 in Japan, mortality reached 60 per cent. Mortality in the U.S.S.R. during the outbreaks of Japanese encephalitis in the Primorye

Territory was 44.8 per cent on the average, ranging from 25 per cent (1941) to 53 per cent (1938). Unlike tick-borne encephalitis there is no residual paralysis. The disease, however, does not always take a severe course and abortive forms also occur. In addition, there are asymptomatic forms proved by the isolation of antibodies from the blood of healthy persons who have not had the disease.

Sources of Infection. Soviet investigators have proved that Japanese encephalitis is a natural foci disease. Reservoirs of the virus are many species of warm-blooded animals, mainly small rodents, and also birds of the sparrow family. The encephalitis virus was isolated in Japan from rats and sparrows; specific antibodies neutralising the virus were found in horses, cows, pigs and dogs. In the U.S.S.R. the virus has been isolated from different species of birds belonging to the sparrow family, and also from horses.

The vectors of Japanese encephalitis are the mosquitoes *Culex tritaeniarhynchus*, *C. bitaeniarhynchus*, *C. pipiens*, *Aedes togoi*, *A. japonicus* and others. These mosquitoes are typical inhabitants of wild natural areas which explains why the natural foci of mosquito encephalitis in the U.S.S.R. have been found to be in poorly populated lowland areas without forests and with numerous lakes and swamps. In rare cases foci have been found in wooded areas. In Japan and Korea, however, these mosquitoes find favourable conditions in inhabited localities, in the environs of villages and towns. Practically the entire territory of Honshu Island, for instance, is a natural focus of mosquito encephalitis.

Mosquitoes infected with this virus are life-long carriers, preserving the virus during hibernation and passing it to subsequent generations transovarially. The development of the encephalitis virus in the mosquito organism depends on external temperature. At 27-30°C tremendous quantities of the virus accumulate in the organism of a mosquito, but when the temperature is below 20° the development of the virus within the body of the mosquito is radically inhibited. Big epidemics of encephalitis in Japan occurred during hot summers. In the U.S.S.R. cases of Japanese encephalitis have been observed only during particularly hot summers.

Epidemiology. Japanese encephalitis has been recorded in Japan, Korea, China, the Philippines, and the Primorye Territory of the U.S.S.R. There have been no cases of Japanese encephalitis in the U.S.S.R. in recent years. There are grounds for believing that Australian X-encephalitis is identical with Japanese encephalitis.

The disease affects mainly rural population groups and also persons engaged in the development of areas which are natural foci of this disease. Big epidemics of encephalitis were recorded among occupation troops in South Korea in the fifties.

In outbreak years in the U.S.S.R., cases were observed only in the period from August to October, i.e., when the mosquito vectors are most active and abundant. In Japan, where the climate is warmer and the period of vector activity is longer, cases occur mainly from June to October, though there may be some in other months of the yèar too.

Prophylaxis. Prophylaxis of Japanese encephalitis is based on extermination of mosquitoes, protection against their attacks and active immunisation.

Early detection and hospitalisation of patients is important, since the outcome of the disease depends to a considerable extent upon proper care and timely serotherapy. Wards must have reliable protection against mosquitoes.

The mosquito control is similar to anti-malaria campaigns (reclamation of marshes, destruction of larvae by poison and petroleum-spraying, the destruction of mosquitoes by DDT and hexachlorocyclohexane, zoological prophylaxis, protection of premises by screens, use of bed curtains, etc.). Since the foci of mosquito encephalitis in the U.S.S.R. are in the main in sparsely populated areas, individual measures of protection (bed curtains, Pavlovsky's netting, repellents, etc.) are important.

In the past the exposed population groups were given a vaccine of the virus which had been accumulated in the brains of mice and rendered harmless by formalin. Inoculation was conducted in April or May. The vaccine was given subcutaneously in two doses of two and three ml with an interval of 10-15 days in between. At present, inoculation against Japanese encephalitis is not carried out in the U.S.S.R., as the disease is not prevalent on its territory.

MOSQUITO ENCEPHALITIDES AND FEVERS

Encephalitis-type diseases or fevers involving the internal organs and transmitted by mosquito bites are found in various parts of the world, especially in the hot zone (Fig. 66). The best known types of encephalitis are the St. Louis encephalitis, American equine encephalomyelitis, yellow fever and dengue. All these diseases are of a viral nature. The viruses of Japanese encephalitis, St. Louis encephalitis, yellow fever, dengue and a considerable number of agents of viral encephalitides and fevers discovered recently in Africa and Latin America (West-Nile encephalitis, Bwamba fever, Ilheus encephalitis and others) have similar antigenic structure, which is an indication of common origin. A brief description of some of these infections follows.

St. Louis Encephalitis. The St. Louis encephalitis named after the town in the U.S.A. where it was first discovered, is caused by a virus immunologically related to the agent of Japanese encephalitis. Pathogenesis and clinical manifestations are very similar to those of Japanese encephalitis but this disease takes a more benign course and mortality is less than 20 per cent. The reservoir of the virus has not been fully determined, though it seems that it may be rodents, birds and cattle. The disease is transmitted by the mosquito *Culex tarsalis.* Prophylaxis is similar to that of Japanese encephalitis.

American Equine Encephalomyelitis. American equine encephalomyelitis is caused by viruses unrelated to the agents of other encephalitides. There are three varieties of this disease caused by interrelated viruses, the Eastern

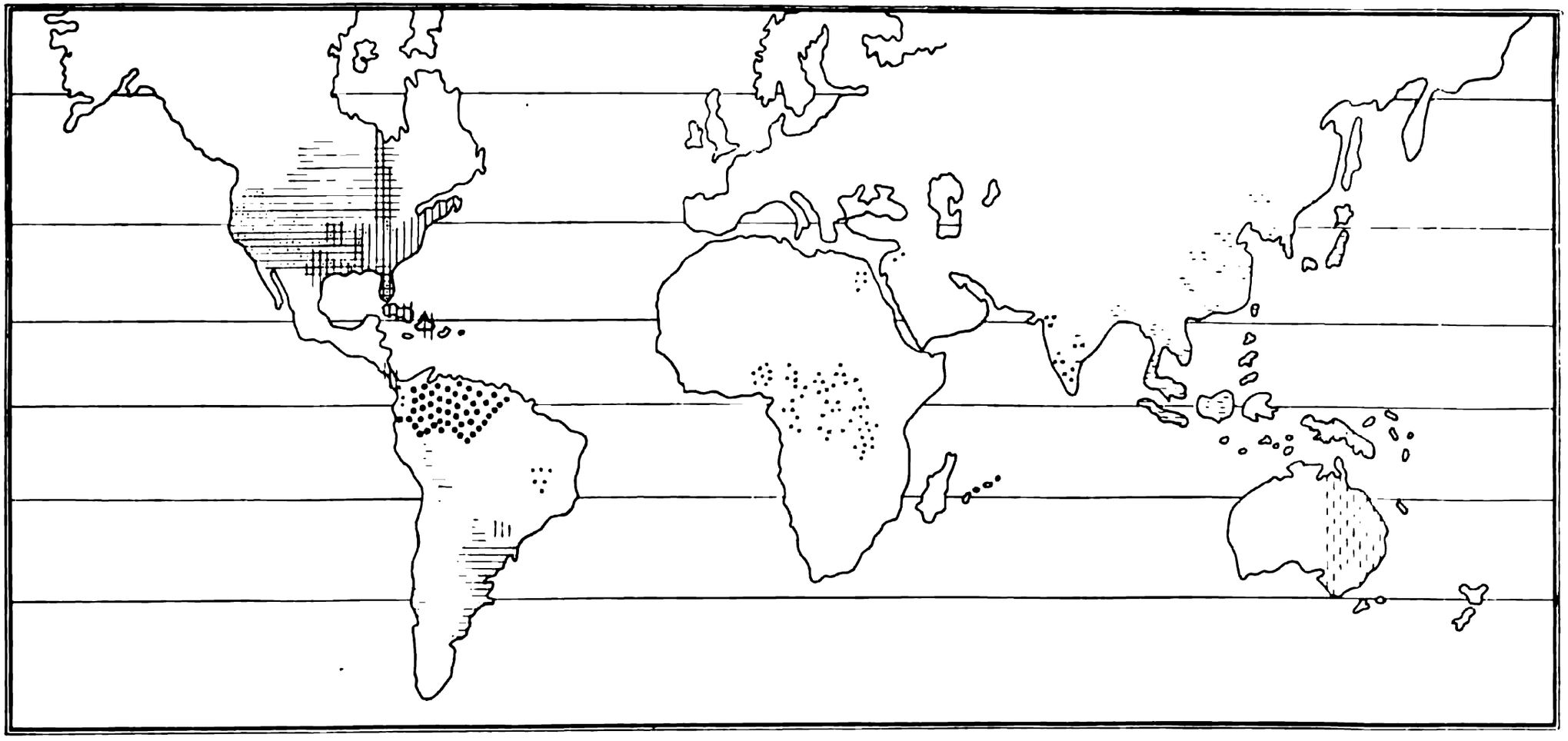

I Far Eastern Group
Japanese type B encephalitis and its varieties
Australian X-encephalitis and Murray valley encephalitis
II American group
Western equine encephalomyelitis
Eastern equine encephalomyelitis
St. Louis encephalomyelitis
Venezuela equine encephalomyelitis
III Tropical viruses of Africa and South America
West Nile, Bwamba Buniamwer, Semliki, Zika, Uganda, Ntaya Island, Ilheus and other viruses

Fig. 66. World distribution of encephalitides (after O. V. Baroyan)

equine, Western equine, and Venezuelan equine forms of which the first takes the most severe course. Following an incubation period of one or two weeks the disease commences with symptoms of fever, meningeal phenomena, lethargy and paralyses. The reservoir is not definitely known, but horses are frequently involved in the epizootic process. The vectors are mosquitoes of the genera *Culex* and *Aedes*, the *Dermacentor* tick and the *Triatoma* bug. The area of distribution is North America (U.S.A., Canada), Latin America (Venezuela, Argentina). Disease caused by the virus of the Eastern equine type have been recorded in Czechoslovakia. Prophylaxis is limited to protection against attacks by mosquitoes and ticks; inoculation of residents of the endemic area is also advisable.

Yellow Fever. Yellow fever is caused by a virus with an antigenic structure similar to that of the agent of Japanese encephalitis. The disease commences after an incubation period of three to six days, sometimes up to 12 days. Basically the disease is a fever involving liver (jaundice) and kidneys, and an intense general intoxication. Albuminuria and hemorrhagic diathesis are observed in severe cases. Mortality ranges from five to 80 per cent.

Two epidemiological forms of yellow fever are distinguished: jungle fever and urban yellow fever. The former is a natural foci disease; the reservoir of the virus is monkeys, and the vectors are different species of mosquito of the genera *Aedes* and *Haemagogus*. There are natural foci in the African and Latin American tropical zones between latitudes 40° North and South. The second epidemiological form developed when the *Aedes aegypti* mosquito (one of the vectors) became synanthropous. It began to live close to man's dwellings, as a result of which yellow fever broke away from the natural foci and became an anthroponosis. The mosquito was carried to various parts of the world by sea transport and yellow fever foci appeared in many warm climate areas (a warm climate is essential for the development of the virus in the body of the mosquito). A considerable number of the yellow fever foci have been eradicated in the past few decades thanks to international quarantine measures. The disease has never been observed in the U.S.S.R.

Prophylaxis consists in the extermination of *Aedes aegypti* mosquitoes, protection against their attacks, quarantine measures in sea transport, clearance of insects from vessels and aircraft in keeping with international health conventions. When people leave for exposed areas, they are given specific inoculation. The vaccine is made from a vacuum-dehydrated live attenuated virus. A single dose of the vaccine is given after dilution as indicated, with water or a physiological solvent. The patient must be isolated and protected against mosquitoes.

Dengue. Dengue is a viral disease whose agent is immunologically related to the virus of yellow fever. The disease commences following an incubation period of four or five days (it might vary from three to ten days) and takes a febrile course, with pains in the joints and muscles, prostration, at times with rashes and hemorrhages. As a rule there are two attacks lasting from four to six days each. Mortality is low. The disease affects man only and is transmitted by the bite of the *Aedes aegypti* mosquito. Dengue is met with in tropical and subtropical zones. Big epidemics have been observed in periods of mosquito activity. Prophylaxis is based on mosquito control and protection against their attacks. Active immunisation with a specific vaccine is also carried out.

HEMORRHAGIC FEVERS

Hemorrhagic fevers comprise a group of viral diseases with a certain similarity in their clinical picture, hemorrhagic syndrome. They are all natural foci diseases and are transmitted by ticks. Some of them are probably identical or very closely related.

Crimean Hemorrhagic Fever. The disease was identified for the first time in 1944 on the Crimean peninsula and was studied by A. V. Kolachev, M. P. Chumakov, A. G. Gorbov and others. The agent, a filtrable virus distinguishable from the agents of other transmissive viruses, was isolated from white mice, cats and monkeys, and passed through people as an agent for pyrotherapy of psychic diseases (attenuated virus causes benign fever conditions).

Following a bite by an infected tick the virus enters the blood stream, causes fever, and affects the capillaries (acute capillary toxicosis); this is accompanied by marked hemophilia. The disease takes an acute course following an incubation period of 7 to 12 days (when volunteers were inoculated the incubation period dropped to two or three days); the main symptoms include fever, headaches, anorexia, nausea and vomiting, edema of the face and injection of sclera; this is followed by the development of an hemorrhagic rash and enanthema; hemophilia appears (nasal, pulmonary, intestinal and other hemorrhages), thrombopenia and leukopenia. In serious cases death results from hemorrhages. Slow recuperation is the most common outcome.

The disease is of a natural foci origin. The possible reservoirs of the virus are hares and other animals inhabiting Crimean steppes. The established vector (from which the

virus has been isolated) is the *Ixodes* tick, *Hyalomma marginatum*. Cases have been observed in summer time, from June to September, but mainly in July and August, among haymakers and harvesters. No cases have been reported in recent years.

Similar diseases have been found in Bulgaria and also in Uzbekistan and other Central Asian Republics, the virus having been isolated from patients and ticks *Hyalomma anatolicum*, which are vectors of the disease in Uzbekistan. Prophylaxis is founded on tick control and protection against attacks by them (see tick-borne encephalitis). Patients are isolated in infectious diseases wards. Precautions must be observed when taking care of the patients because there have been cases of hospital staff being infected.

Omsk Hemorrhagic Fever. The disease was discovered in 1944 in the Barabinsk steppe, Omsk Region. It has been studied by R. M. Akhrem-Akhremovich, M. P. Chumakov, A. V. Fedyushin and others.

Immunologically the agent of Omsk hemorrhagic fever is very similar to the virus of tick-borne encephalitis and has a practically identical antigenic structure. It is passed through white mice. The virus differs from agents of Crimean hemorrhagic fever and the Far Eastern nephrose-nephritis.

Infection occurs as the result of a tick bite. A 7-12 day incubation period is followed by fever with an hemorrhagic syndrome. It takes a more benign course than Crimean fever.

Omsk hemorrhagic fever is a natural foci disease. The reservoir of the virus is voles which inhabit the forest-steppe areas. Many species of mouse-like rodents and muskrats are involved in the epizootic process. The vectors are the *Dermacentor pictus* and other ticks. Antibodies have been found in domestic animals in natural foci zones. Man is infected during field work in the steppe. Cases occur between May and August.

The hemorrhagic fever of Bukovina (studied by A. V. Kolachev, Y. Y. Kosovsky) is probably similar to, if not identical with Omsk hemorrhagic fever. Serological research (M. P. Chumakov) has confirmed this. This disease is found in the forest-steppe zone of Bukovina and the suspected vector is an *Ixodes* tick *Ixodes ricinus*. Similar diseases have

been observed in the Transcarpathian regions and on the Malay Peninsula.

Prophylaxis is similar to that of tick-borne encephalitis, including the use of formaldehyde-killed vaccine made from local strains of the virus.

Hemorrhagic Nephrose-Nephritis. The disease was first observed in the thirties in the U.S.S.R. and North Manchuria (described as a hemorrhagic fever), and then in the fifties in South Korea. It has been studied in the U.S.S.R. by A. V. Churilov, A. A. Smorodintsev, M. P. Chumakov and others. The agent is an insufficiently studied virus which differs serologically from the agents of the two nosological forms described above.

The disease commences following an incubation period of 11-24 days and manifests itself in fever, hemorrhage and lesions of the kidneys. Mortality varies from three to 12-14 per cent. The kidney syndrome is the main feature distinguishing this disease from other hemorrhagic fevers.

Its epidemiology still requires study. The origins of the disease are most likely natural foci and the reservoir of the virus is found in voles and other mouse-like rodents. The *Gamasidae* ticks are suspected vectors. The natural foci are found in marshy areas and in flood regions overgrown by thick grass. Outbreaks have been observed in summer and early autumn months (May to October). The biggest epidemics occurred in 1951-53 among the occupation troops in South Korea.

Measures of prophylaxis have not been worked out. Protection against tick attacks is recommended.

Hemorrhagic fevers with a kidney syndrome have also been described in the Tula and Yaroslavl regions (M. P. Chumakov), but these have a more benign course. They are probably identical with hemorrhagic nephrose-nephritis.

TETANUS

Etiology. The causative agent of tetanus (*Clostridium tetani*) is, like the agents of gas-gangrene and botulism, one of the spore-forming anaerobic rods. The spores of the *Bacillus tetani* are very resistant and in this respect are similar to the spores of *Bacillus anthracis* (see "Anthrax"). *Bacillus tetani* produces a strong neurotropic toxin.

Pathogenesis. Infection with tetanus occurs when *Bacillus tetani* enters a wound with earth, or through clothes or other environmental objects. Tetanus develops only when there are anaerobic conditions in the wound. In this case the spores of the *Bacillus tetani* germinate, multiply in the wound and liberate the toxin. The latter spreads along the nerve fibres and possibly in the blood stream causing the nerve tissue lesions peculiar to tetanus. Death is a frequent outcome of this desease. The incubation period as a rule lasts one or two weeks but it can be less (two or three days) or more; recovery is accompanied by the development of a lasting immunity.

Sources of Infection. *Clostridium tetani* is widespread in nature. It is a normal inhabitant of the intestine of ruminants and is frequently present in the intestine of man without causing any harmful effects. Owing to fecal contamination it is frequently found in soil and on dirty objects.

Routes of Transmission. Since *Bacillus tetani* is virtually ubiquitous, the epidemiology of tetanus is determined not so much by the spread of the agent, as by the pathogenesis of tetanus, which is a wound infection. Hence, tetanus morbidity is confined in the main to victims of farm injuries

or street accidents; it also occurs among the parturients and newborn. Tetanus morbidity rises sharply in war time due to war injuries. Tetanus may also result from autoinfection (cryptogenic tetanus).

Epidemiology. Tetanus cases in the U.S.S.R. are mainly of a sporadic nature and incidence is of the order of 0.1 per 10,000.

Diagnosis. Diagnosis of tetanus is established on the basis of its specific clinical picture. Laboratory diagnosis is difficult and the isolation of the pathogen from the affected tissues is a lengthy process.

Prophylaxis. Prophylaxis is based on safety precautions to guard against injury and the protection of persons who are in danger from this infection by active and passive immunisation.

Active immunisation is carried out by means of two subcutaneous injections of a tetanus anatoxin in two doses of one and two ml with an interval of two or three weeks. Servicemen or army recruits and groups of population (navvies, tractor drivers, etc.), residing in areas afflicted with tetanus, are covered by regular immunisation campaigns. Tetanus anatoxin is most commonly used in combination with inoculations against typhoid and diphtheria, and owing to its poor reactogenicity it is added to the other preparations shortly before the inoculation. Certain mixed vaccines contain the tetanus anatoxin (for instance the intestinal polyvaccine). A mixed vaccine (diphtheria, whooping cough and tetanus) is useful for children. Revaccination is done after a year, with one dose of two ml of anatoxin. Post-vaccination and revaccination immunity is retained for many years.

Passive immunisation (seroprophylaxis) is carried out by subcutaneous inoculation of 1,500 active units of anti-tetanus serum. This serum is administered in the case of wounds contaminated with earth, rags, straw, etc., in wounds involving the crushing of soft tissues, in open bone fractures, in bullet and stab wounds, in burns, frost-bite and snake bites. To avoid anaphylactic shock, the dose of serum is divided into two according to Bezredke's method, the first portion being from 0.1 to 0.3 ml and the rest given two hours later.

Since the action of the serum lasts only up to 10-15 days, passive-active immunisation is advisable in the above-mentioned injuries. The patient is given one ml of anatoxin and 15 minutes later, the serum; two weeks later the second dose of two ml of anatoxin is administered. Every case of tetanus is reported to the district sanitary-epidemiological station. With the introduction of seroprophylaxis and active immunisation against tetanus this disease ceased to be an inevitable concomitant of injuries, even in time of war. The efficiency of active immunisation was proved during the Second World War, when despite the unprecedented scope of injuries the losses caused by tetanus were insignificant.

ANTHRAX

Etiology. The pathogenic agent of anthrax is a spore-forming anaerobic bacillus (*Bacillus anthracis*). It forms a capsule in the organism and when exposed to air forms spores. The spores of *bacillus anthracis* are extremely stable; in natural conditions they remain viable in the soil for scores of years, are strongly resistant to light, temperature and humidity variation. Disinfectants (phenol, sublimate, formalin) in standard concentrations kill the bacillus only if applied for several days. Reliable sterilisation is achieved by dry heat at 140°C applied for three hours, by autoclave treatment at 120°C for 20 minutes, or by treatment in a steam formalin chamber for 40 minutes. Unlike the spores, the vegetative forms of *Bacillus anthracis* are unstable and perish in 30 minutes at a temperature of 56° and when acted upon by disinfectants in standard concentrations.

Pathogenesis. The portal of entry may be the skin or the mucous membranes, the respiratory or the digestive tract; accordingly there are various clinical forms of the disease. When infection occurs through skin abrasions, a necrotically inflamed focus develops at the site where the pathogen lodges (a carbuncle) and septicemia may follow. When infection occurs through the lungs hemorrhagic bronchopneumonia develops rapidly and as a rule is fatal. When infection occurs through the intestine, necrotically inflamed foci sepsis and intoxication develop, nearly always resulting in death. Incubation period is not longer than two or three days; as a rule man is not a source of infection; recovery leads to the development of a lasting immunity.

Sources of Infection. Anthrax is a zoonosis. The reservoir of the pathogen is herbivorous animals which have this disease mainly in the form of an intestinal infection. The animals contract it when they digest grass contaminated with *Bacilli anthracis*, and in their turn contaminate the soil of the pastures by anthrax bacilli which quickly form spores in the presence of air. Since these bacilli are remarkably stable, the contaminated pastures remain dangerous for many years ("the cursed fields"). Animals suffering from anthrax develop sepsis with a tremendous production of bacilli anthracis in the blood, therefore, the disease may be transmitted by blood-sucking arthropoda, mainly the diptera, horse-flies, biting flies. These epizootics can spread very rapidly. All species of herbivora are susceptible to anthrax. The epizootics of anthrax are found both among domestic animals (sheep, pigs, cows) and among wild animals (deer, elk).

Routes of Transmission. The most common form of anthrax in man is the cutaneous form. Infection occurs after handling sick animals or the products of animal husbandry, such as skin, wool, etc. Infection is also possible as a result of a bite by blood-sucking diptera. The gastroenteric form of anthrax is less frequent but it does occur when meat, sausage or milk, obtained from animals suffering from anthrax, are ingested. It is natural that anthrax should occur particularly among certain occupational groups: cattle-tenders, veterinary surgeons, zootechnicians, workers at tanneries and wool-making enterprises. Consumers of animal husbandry products can also be infected. The pulmonary form of anthrax—ragman's disease—which existed in Russia before the Revolution, is not found today owing to better regulations at dumps and better anthrax control measures.

Epidemiology. Anthrax was quite widespread in Russia before the Revolution. For instance, during the decade preceding the First World War, the average annual anthrax morbidity was 16,500 cases (L. V. Gromashevsky). In the years of Soviet power anthrax morbidity went down radically and the annual average in 1953-55 varied from 1,184 to 1,279. Cases might be observed at any season of the year but mainly in July-September. Anthrax is found all

over the world, particularly in Turkey, Iran and Afghanistan.

Laboratory Diagnosis. Laboratory diagnosis of anthrax is comparatively simple. It is achieved by bacterioscopy, by planting the culture in nutritive media and by infecting mice and guinea-pigs. Analysis is performed on punctates and the scrapings of anthrax carbuncles, sputum, the contents of the intestine in pulmonary and gastro-enteric forms of the disease, and sections. The laboratory material should be carefully packed to avoid infection of those handling it.

Prophylaxis. Prophylaxis is based mainly on measures of veterinary control. These include isolation and treatment of sick animals, sanitary supervision of slaughtering, disinfection measures in the focus, preventive inoculation of animals, etc. Knives or firearms should not be used when slaughtering animals infected by anthrax, and the carcasses of animals killed by the disease must not be cut up as the anthrax bacilli in the blood, in the intestine, or in the internal organs in the presence of air form spores. This process does not take place inside the carcass where anaerobic conditions obtain. The carcasses of animals which have died from anthrax are decontaminated at destruction plants or are buried in special cattle burial-grounds at a depth of not less than two metres. If pathological investigation is necessary to confirm the diagnosis, a piece of the ear of an animal is sent for biopsy and the cut place is cauterised with hot iron.

Prophylaxis of anthrax in people is restricted to the observance of rules of hygiene when handling cattle, during slaughtering and when handling raw hides and wool. The raw hides suspected of anthrax are subjected to the Ascoli precipitation reaction. The infected hides or those suspected of being infected with anthrax are salted. In addition, inoculation is carried out in areas afflicted with anthrax.

The anti-anthrax vaccine STI consists of live bacilli of anthrax with attenuated virulence. Vaccination is conducted epicutaneously, as in smallpox vaccination. The ampule containing the vaccine is shaken (if the vaccine has been prepared in dry form it is first diluted in a physiological solvent or water to the volume indicated on the label), and applied with a pipette to the skin of the shoulder in two

places; then five scratches are made by a scarificator through each drop, the vaccine is rubbed in with the flat side of the scarificator and left to dry. If the vaccine has taken, two or three days after the vaccination scabs will appear at the inoculation sites and then fall off.

Cattle-tenders, veterinary workers and workers in meat-packing, hide and wool enterprises in areas afflicted with anthrax, and also people handling raw materials arriving from such areas, should be inoculated.

When it is known that there has been contact with material infected with anthrax and infection is suspected (for instance, a cut on the hand while dressing a carcass, hide, or wool infected with anthrax; eating of meat from an animal sick with anthrax), 60 to 100 ml of anthrax serum should be given intramuscularly or 200,000 units of penicillin daily for three or five days.

An anthrax patient is isolated throughout the illness. The patient suffering from the cutaneous form may be discharged from hospital after the ulcer scars and the scab drops off; in gastro-enteric and pulmonary forms the patient is discharged after two negative results of bacteriological examination of feces or sputum have been obtained. The contacts are not segregated but are kept under medical observation for eight days, and this should also be done in all other cases when contact with material contaminated with anthrax is suspected. The district sanitary-epidemiological station is notified of every case of anthrax.

Disinfection has to be carried out in the seat of infection; linen is decontaminated by boiling for one hour in a one or two per cent soda solution. Clothing and bedding is treated in steam chambers (110°C, 1.5 atm., 1-1.5 hrs), fur and leather articles are treated in steam formalin chambers, various surfaces are treated with 20 per cent chloride of lime, ten per cent caustic soda or ten per cent formalin; refractory objects are treated with fire.

The corpses of anthrax patients are wrapped in a cloth that has been soaked in a ten per cent solution of chloride of lime, the bottom of the coffin and the corpse when placed in it are covered with a layer of dry chloride of lime.

GLANDERS

Etiology. The agent of glanders is *Actinobacillus mallei.* The bacillus of glanders is not very viable in environment. It can remain viable for several days in manure; standard concentrations of disinfectants kill it readily.

Pathogenesis. Infection occurs through abrasions of skin and the mucous membranes. Upon reaching the organism the microbes cause local lesions (nodules) and spread in the organism with the blood stream settling in the skin, in the mucous membranes and in internal organs, where they cause the formation of pustules, ulcers (skin, mucous membrane) and abscesses (internal organs). The disease may take an acute or a chronic course. The incubation period lasts three or five days; the infectious period lasts while there are pustules, ulcers and abscesses, since glanders bacilli may be discharged with their contents. The immunity aspect requires further study.

Epidemiology. Glanders is a disease of horses and other solid-hoofed animals; it may also affect beasts of prey of the feline family. Man is almost always infected by horses, though there have been cases of infection being transmitted from man to man (members of one family, medical workers). In horses the disease generally takes a chronic course; the pathogen is discharged with the content of the abscess, ordinarily through the nose. Glanders incidence is of an occupational nature. It occurs mainly among horse-tenders, veterinary workers, jockeys and cavalry men. Incidence among people is related to the epizootological state of glanders. Glanders in human beings has now practically been

eliminated in the U.S.S.R., since its incidence in horses has been suppressed over a large part of the country.

Laboratory Diagnosis. Laboratory diagnosis is possible by isolating the culture of bacteria by infecting guinea-pigs and cats with pus, punctates and sections of organs. Serological diagnosis is made by the complement fixation test, and the allergic mallein test is used in animals.

Prophylaxis. The prophylaxis of glanders is based first of all on veterinary measures to combat glanders in horses. Horses suffering from glanders are detected and brought together in "mallein" farms. The staff at these farms must observe stringent rules of personal prophylaxis: the wearing of working overalls and gloves, disinfection after work, etc.

A glanders patient is isolated in a separate ward in the infectious department of a hospital for the duration of the clinical manifestations of the disease. This applies to both acute and chronic forms of glanders. At his home the patient's underwear, bed-clothes and other objects used by him are disinfected, and his contacts are placed under medical observation for 15 days. When attending to a patient the medical personnel should bear in mind the possibility of ward infection and should use special clothes (overalls, slippers, rubber gloves), observe strict rules of hygiene and practise current disinfection. When the patient is discharged or in the event of his death a final disinfection is carried out in the ward. In view of the possibility of an outbreak of a latent chronic process, convalescents are kept under medical observation for not less than one year.

FOOT-AND-MOUTH DISEASE
(Stomatitis Aphthosa)

Etiology. The agent of foot-and-mouth disease is a small filtrable virus. Three serological variants of the virus (O,A,C), which do not have cross immunity, are known. The virus is stable and can remain viable in animal excreta and matting for two months, and in wool for up to two weeks; in meat it dies in two or three days owing to the acid medium. The best disinfectants are formalin (1 %co solution) and alkali.

Pathogenesis. The portal of entry might be either the digestive tract, skin abrasions, or mucous membranes. The virus spreads with the blood causing a fever and aphthous lesions of the mucous membranes and skin. The incubation period lasts from two to eight days. Patients suffering from foot-and-mouth disease are virtually non-infectious; recovery is accompanied by the development of stable typospecific immunity.

Epidemiology. Foot-and-mouth disease is a zoonosis of domestic animals. It afflicts cows, sheep, pigs, which in their turn can infect man. It is contracted by man while tending sick animals or after drinking raw milk from infected animals, since the virus is discharged with the excreta of ulcers, with saliva, urine and milk. Meat does not play any part in the transmission of foot-and-mouth infection. Cases of foot-and-mouth disease among people are comparatively rare and usually of occupational nature, occurring among veterinary workers, cattle-tenders and milkmaids. They are associated with epizootics of foot-and-mouth disease among animals.

Laboratory Diagnosis. Laboratory diagnosis is made by infecting guinea-pigs with the contents of pustules and aphthae. As a rule, this is done at veterinary-bacteriological laboratories.

Prophylaxis. The prophylaxis of foot-and-mouth disease is based on veterinary measures aimed at controlling this infection in animals.

In the event of an epizootic of this disease it is absolutely essential to ensure that milk for sale to the public is boiled or pasteurised; whenever effective control is impracticable, the free sale of milk in markets should be prohibited. People working on farms where there is an outbreak of foot-and-mouth disease should observe measures of personal protection (working overalls and gloves). Quarantine measures are used in epizootic foci.

The patient is isolated for the duration of the clinical manifestations of the disease. Personal disinfection (linen, clothing) is advisable when the patient is discharged from the hospital.

RABIES

Etiology. The agent of rabies is a filtrable virus which was isolated and studied by Louis Pasteur (1880), though the viral nature of the agent was proved at a much later date (Negri, 1903; Calkins, 1907). The virus of rabies forms specific inclusion bodies, Negri bodies—in the nerve cells of affected animals and people, which are intracellular colonies of the virus. The virus remains viable for several months in brain tissue in a dried state or with the addition of glycerine. Disinfectants in standard concentrations kill the virus in several hours. However, it can remain alive for two months in a 0.5 per cent phenol solution at 4°C.

Pathogenesis. The portal of entry is the skin and mucous membranes. The disease is contracted either as the result of a bite by an infected animal or if the saliva of such an animal contaminates abrasions. The virus lodges in the nerve fibres and nerve endings, and spreads through the organism centripetally along the nerve fibres and cells. Upon reaching the central nervous system it multiplies in nerve tissues affecting the nerve cells of the brain and the spinal cord (Negri bodies are found mainly in the nerve cells of the hippocampus), from which they progress centrifugally by the nerve fibres and reach the salivary glands. The incubation period varies considerably and depends upon the place and the size of the bite; the farther the bite from the head, the longer the incubation period. Ordinarily the disease sets in within two or three months but the incubation period can vary from 12 days to one year. The infectious period continues from the beginning of the disease to death.

Sources of Infection. Rabies afflicts many species of animals since all mammals are susceptible. However, its principal host reservoir in nature is wolves, dogs, foxes and other representatives of the canine family. The natural foci of rabies are mainly associated with wolves but rabies in dogs is of much greater importance for man. According to V. D. Solovyov, 88 per cent of all rabies cases in people in the U.S.S.R. have been caused by dogs, 4.7 per cent by cats, four per cent by wolves and 3.3 per cent by other wild and domestic animals. The disease in animals is transmitted with bites or saliva. The infected animal begins to discharge the virus with saliva four to seven days before the appearance of symptoms, and the disease lasts from two to five days. The symptoms of rabies in animals are a sharp change in behaviour, fearfulness or excessive irritability, frequently accompanied by attacks of fury. The sick dogs, cats and other animals attack and bite anything within sight without provocation; they swallow various inedible objects. Owing to the spasms of the muscles of deglutition the voice is altered (hoarse barking or mewing), swallowing becomes difficult and is followed by paralysis and death. Sometimes rabies takes the paralytic form from the very beginning; the animal is incapable of swallowing, though it is not excited (dumb rabies); it dies within a short time because of progressing paralysis.

Epidemiology. Rabies is found on all continents. Some countries have eradicated rabies either completely or to a considerable extent thanks to the extermination of wolves and introduction of rules for owners of pets. In the U.S.S.R., following a post-war rise in the incidence of rabies, the disease has been steadily declining. Thus, the number of rabies cases since the post-war peak in 1951 dropped to one fourth of the figure by 1959. This has been achieved thanks to the rounding up of stray dogs and the enforcement of regulations for dog-owners. In a number of areas where rabies was not infrequent it has been eradicated completely (Donbas, Moscow Region). All this points to the possibility of the total eradication of rabies in people and the maximum suppression of epizootics, above all by eradicating rabies in dogs.

In the northern areas of the U.S.S.R. (the polar regions,

Kamchatka), a rabies-like disease is observed in arctic foxes and dogs. The study of the virus isolated from these animals leads us to believe that this disease is identical with rabies.

Laboratory Diagnosis. Diagnosis of rabies is arrived at through histological examination of the brain tissue to detect Negri bodies, and also by biological tests. Sections of the brain of people or animals who have died of rabies, removed under aseptic conditions and taken from several places, including some from the hippocampus, are sent for biopsy. The pieces of brain are packed in sterile glycerine or in sterile containers and sent to the laboratory. If the material is intended for histological examination only (without the biological test), it may be fixed in acetone or methyl alcohol (undiluted) and sent for examination through the post.

Prophylaxis. Prophylaxis of rabies is based on the following principles:

a) registration of dogs, observance of regulations covering the possession of dogs and veterinary supervision; b) the rounding-up and destruction of stray dogs and cats; c) preventative inoculation of dogs as an auxiliary measure; d) destruction of wolves and jackals; e) destruction of rabid animals, isolation of animals which are suspected and placing of them under veterinary observation.

Dogs and other animals which have bitten people or other animals should be taken to a veterinary centre and kept under observation for 14 days.

When signs of rabies appear in an animal the owners must isolate the animal or have it killed and protect the carcass from other animals. The case is reported to the local veterinary or medical institution and to the militia. The place where the animal was kept is washed out with disinfectant, clothing polluted by saliva is boiled and washed, or pressed with a hot iron.

All persons bitten by a rabid animal or an animal suspected of rabies are subject to active immunisation or combined active and passive immunisation.

It is not advisable to arrest the bleeding of a bitten person during first-aid treatment; instead, it should be increased by using a venous tourniquet or cupping—not by pressing.

The wound should be thoroughly washed with a weak solution of potassium permanganate or warm water; if less than one hour has passed since the bite, the wound should be treated with iodine, a two per cent solution of formalin or alcohol. Treatment of the wound does not mean that subsequent inoculations are not needed.

The antirabic vaccine obtained in 1885 by Pasteur has been an important means of combating rabies. Pasteur obtained the vaccine having attenuated the virus of rabies by multiple passages through the brain of a rabbit. As a result the virus of rabies (the "street virus") altered its properties and became a vaccinal strain with greatly attenuated virulence when administered subcutaneously to a dog or to men (the "fixed virus"). As the vaccine is given to those bitten and infected with rabies still in the incubation period, the antirabic inoculation is in fact an early specific treatment. Prior to the introduction of Pasteur's treatment the rabies death rate ranged from 30 to 35 per cent of those bitten by rabid animals. Today mortality among those inoculated is not more than 0.2-0.3 per cent. The antirabic gamma globulin, i.e., the purified concentrated medicinal serum, is also used in prophylactic therapy. It is obtained by the immunisation of horses and other animals with antirabic vaccines.

The vaccines used today differ considerably from the initial vaccine developed by Pasteur. The vaccines used in the U.S.S.R. are prepared from rabbit or ram brain using the Fermi or Phillips methods. The Fermi vaccine is prepared by exposing a five per cent suspension of brain tissue of animals infected with the fixed living virus of rabies to a one per cent phenol solution. The vaccine is poured into ampules ready for use. It may be kept for five months from the date of preparation. The Phillips vaccine is a ten per cent brain tissue suspension in glycerine; prior to application it is diluted (1:20) with a physiological solution (also possible in a 0.5 per cent phenolised physiological solution). The undiluted vaccine remains effective for one and a half months. Diluted vaccine which is not used on the same day should be destroyed.

The dosage of the vaccine and gamma globulin and the period over which inoculations should be carried out

The Chart of Indications, Dosage and Duration

	Nature of contact	Data on the animal		Inoculations
		At the time of the bite	During 14 days of observation	
Contamination with saliva	Uninjured skin	Healthy	Healthy	Not indicated
			Took sick, died or disappeared	Should be started immediately upon appearance of first symptoms of the disease in the case of the animal's death or disappearance
	Injured skin and uninjured mucous membranes	Healthy	Healthy	Not indicated
	„	Healthy	Took sick, died or disappeared	Should be started immediately upon appearance of first symptoms of the disease, in the case of the animal's death or disappearance
	„	Sick with rabies or killed, ran away, unknown animal	—	Should be started immediately
Mild or medium severity bite	Isolated shallow bites of the shoulder, forearm, low-	Healthy	Healthy	Not indicated

Table 6

of an Antirabic Vaccine Inoculation Course

Dosage and duration of inoculations in days		Notes
Fermi	Phillips	
—	—	
3 ml × 12	From 0.5 to 2.5 ml × 12	
—	—	
3 ml × 12-15	From 0.5 to 2.5 ml × 12-15	
3 ml × 15-20	From 0.5 to 2.5 ml × 15-20	
—	—	The course of inoculations is not indicated provided there are positive data on the animal (a pro-

	Nature of contact	Data on the animal		Inoculations
		At the time of the bite	During 14 days of observation	
	er extremities or the body, and also saliva on injured mucous membranes			
Mild or medium severity bite	Rare shallow bites of the shoulder, forearm, lower extremities or the body and also saliva on injured mucous membranes	Healthy	Took sick, died or disappeared	Should be started immediately upon appearance of first symptoms of the disease, in the case of the animal's death or disappearance
	"	Sick with rabies or killed, ran away, unknown animal	—	Should be started immediately

Continued

Dosage and duration of inoculations in days		Notes
Fermi	Phillips	
		voked bite, a vicious dog, a dog kept in isolation, area free from rabies). The animal, however, is placed under veterinary observation, to start inoculations immediately upon appearance in the animal of first symptoms of rabies. A conditional course is indicated if the data on the animal are unfavourable: 3 ml after Fermi, from 0.5 to 2.5 ml after Phillips with a gradual tarnsition, daily for 5 days, and then every third day to the end of observation
Medium severity bite 6 ml × 15 and 3 ml × 10 Mild bite 3-4 ml × 20-25	Medium severity bite from 0.5 to 2.5 ml × 15 and 1 ml × 10 Mild bite from 0.5 to 2.5 × 15	
6 ml × 15 and 3 ml × 10	From 0.5 to 2.5 × 15 and 1 ml × 10	

	Nature of contact	Data on the animal		Inoculations
		At the time of the bite	During 14 days of observation	
Grave bites	Multiple bites of the body and extremities, any bites of the hands, head, face and neck, any bites inflicted by wild carnivora	Healthy	Healthy	Should be started immediately
	"	Healthy	Took sick, died or disappeared	Should change over to an intensified course upon appearance of first symptoms of disease, in the case of the animal's death or disappearance
	"	Sick with rabies or killed, ran away, unknown animal	—	Intensified course should be started immediately

Continued

Dosage and duration of inoculations in days		Notes
Fermi	Phillips	
3-4 ml	By 2 ml beginning with 1st day	Conditional course: daily for the first 7 days, and then every 3rd day to the end of observation. The conditional course may be substituted by one daily dose of antirabic gamma globulin
8 ml × 20 and 4 ml × 10 Interval 10 days 4 ml × 10	With the 1st day 4-5 ml × 20 and 2-2.5 ml × 10 Interval 10 days 2 ml × 10	An intensified course of vaccination or combined treatment with the antirabic gamma globulin and the vaccine in hospital conditions. Intensified course: 8 ml of vaccine (Fermi type) daily for 20 days, interval for 10 days and a repeated course of 10 days by 4 ml. Combined treatment: immediately after the bite, but not later than 3 days, the antirabic gamma globulin is given and a course of inoculations is started 24 hrs. later; 5 ml of Fermi vaccine daily, for 25 days
8 ml × 20 and 6 ml × 10 Interval 10 days 4 ml × 10	With the 1st day 4-5 ml × 20 and 3 ml × 10 Interval 10 days 2.5 ml × 10	

• depend on the site and the nature of the bites and data concerning the animal which inflicted the bites. Table 6 shows various systems of inoculations against rabies by vaccine and gamma globulin. The following should be noted as supplementary to this table.

The dosage of vaccines is given for adults and children over 14. Children from six to 14 are given three-fourths of the adult dose, children under five—one half. Doses of from 0.5 to 2.5 ml of the Phillips vaccine are prescribed, at first gradually increasing the quantity (0.5-0.75-1 ml, etc.), and then keeping the dose at 2.5 ml for the remainder of the inoculation course. The vaccine is administered strictly subcutaneously in the abdomen, somewhat away from the midline on a level with or below the navel. Alcoholic drinks are forbidden throughout the course of treatment and in the months immediately following it, and patients should not overwork or become overheated.

Antirabic gamma globulin is administered intramuscularly in the following doses: children under two—5 ml, from three to twelve—in keeping with the formula 3+the number of years (for instance, the dose for a five-year-old child would be 3+5=8 ml); adults—0.25 ml per kg of weight. The administration of gamma globulin is made with a preliminary desensitisation according to Bezredke's method: at first 0.1 ml of gamma globulin is given intracutaneously (gamma globulin is diluted 1:10 in a physiological solution), after 30 minutes 0.1 ml of whole gamma globulin is administered subcutaneously and in another 30 minutes the entire dose is administered intramuscularly. If the skin test reveals increased sensitivity and yet gamma globulin has to be administered (vital indications), then double desensitisation of the organism is carried out by the subcutaneous administration of 0.05 ml of whole gamma globulin and after 30 minutes 0.1 ml; simultaneously antihistamine preparations are used: 0.015 ml of dimedrol, three or four times daily. An hour later the entire dose is slowly administered intramuscularly; adrenalin and other antishock drugs should be kept in readiness.

In rare cases antirabic inoculations give rise to complications in the form of paralyses or pareses and sometimes even cause death. On the average there are complications

in one out of 3,000-5,000 cases. There are various reasons for the complications, but the fact that they can occur requires a thoroughgoing approach to the prescription and carrying out of inoculations so that they are not done unnecessarily and at the same time so that a person infected with rabies is not left uninoculated.

Rabies patients are compulsorily isolated in a separate ward and given individual attention. The district sanitary-epidemiological station is immediately notified. The medical workers who attend to the patient must take precautions against infection, wear rubber gloves and inspect their skin. A course of inoculations should be taken if infection is suspected.

TRACHOMA

Etiology. The causative agent of trachoma belongs to big viruses; it may be seen in a microscope if tinted by Romanovsky's method. The virus forms cytoplasmatic inclusion bodies which are accumulations of elementary bodies (intracellular colonies of the virus) in the cells of the epithelium of the conjunctiva. Unlike the majority of viruses the agent of trachoma is sensitive to synthomycin and to some other antibiotics and chemodrugs. It is not very viable in environment and apparently survives for only a few hours. The virus of trachoma is strictly a parasite of man. Experimental infection has been induced only in monkeys, other laboratory animals being non-susceptible.

The agent of follicular conjunctivitis resembles trachoma virus in antigenic structure and in other biological properties, which has led certain investigators to identify the two diseases. The virus of trachoma belongs to the family of *Chlamydozoa*, other members of which are the agents of psittacosis, lymphogranulame inguinal and some other diseases.

Pathogenesis. The agent of trachoma is distinguished by a marked tissue tropism; it multiplies only in the epithelium of the conjunctiva of the eye. Upon reaching the conjunctiva it multiplies and sets up chronic inflammation of the connective tissue of the eye. A specific feature of trachomatous inflammation is the diffused infiltration of the adenoid tissue with the formation of follicules with subsequent degeneration and scarring. Following an incubation period of 5-12 days, there is gradual onset of the disease, which then takes a chronic course. Three stages are distinguished:

in the first stage (trachoma I) there is a gradual aggravation of the inflammatory phenomena, infiltration of the conjunctiva and the development of follicules; during the second stage (trachoma II) the degeneration and decomposition of the follicules and the beginning of scarring take place; in the third stage (trachoma III) scarring is the predominant process.

Neglected trachoma leads to entropion scarring, the destruction of the glandular apparatus of the conjunctiva, lesions of the cornea (keratitis, pannus, ulcer) and frequently to blindness. The virus remains in the organism throughout the course of the disease. There is no immunity.

Sources of Infection. The reservoir of the virus is man, and the source of infection, patients. In the chronic form of the disease the patient is infectious for a long period, sometimes for years. The degree of infectivity varies with the stage of the disease. Patients are particularly infectious in the first stage, and with the development of scarring the infectivity declines. Inasmuch as the disease always takes a clinically expressed form and is a lengthy one, too, no forms of carrying are observed in trachoma.

Routes of Transmission. The infectious entity is discharged into the environment with the excreta of the conjunctiva of the patient's eye. Infection occurs in the course of domestic contact with the patient through dirty hands and the common use of towels, water, etc. There are grounds for believing that flies may serve as mechanical vectors in endemic districts.

Susceptibility to trachoma is apparently universal. This is confirmed by cases described in literature of artificial infection with trachoma which have almost always resulted in the development of the disease.

Epidemiology. Trachoma is widespread in different countries, particularly in the colonial and dependent countries. Trachoma statistics then are either incomplete or non-existent and only approximate estimates may be made about the degree to which the population is afflicted with trachoma. According to Morax and Petit, there are approximately 90-100 million people suffering from trachoma in the world; it is particularly widespread in Eastern countries. In Egypt, up to 90 per cent of the population suffer

from trachoma, in India the incidence among school children reaches 90 per cent, and among servicemen, up to 76 per cent; in Palestine a recent estimate showed that there were 400,000 trachoma patients and that 26.2 per cent of blindness there was caused by trachoma. Trachoma is found in Italy, Spain, France, the Netherlands and other countries. It is a typically social disease afflicting the poorest section of the population living in bad housing conditions and having a poor knowledge of hygiene.

Trachoma was prevalent in Russia before the Revolution. According to the available data there were 1,020,833 trachoma patients in the country in 1913. Trachoma morbidity was particularly high among nationalities living in semicolonial conditions: the Chuvash, Tatars, Mordovians, Mari, Turkmen and others. Trachoma incidence has dropped radically in the years of Soviet power although the remnants of former foci are still present in several parts of the country.

Prophylaxis. Trachoma control in the U.S.S.R. is carried out in conformity with the decision of the All-Union Central Council of Trade Unions and of the Council of People's Commissars of the Russian Federation of November 27, 1927. A special network of medical and preventive institutions has been set up in areas afflicted with trachoma, and the population is examined with a view to detecting trachoma sufferers. All patients are subject to compulsory treatment (in hospitals or polyclinics) and are subsequently kept under medical observation. In keeping with the decisions of the Central Committee of the C.P.S.U. and the Council of Ministers of the U.S.S.R. of January 14, 1960, the remaining foci of trachoma are being eradicated.